MODERN AUTOMATIC ELECTRIC BLOCK SIGNAL INSTALLATION

BY

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Armour Institute of Technology

1908

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Modern automatic electric
block signal installation

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A MODERN AUTOMATIC ELECTRIC BLOCK SIGNAL INSTALLATION.

A THESIS

presented by

Farru Ernest Brainard

to the

PRESIDENT AND FACULTY

of

ARMOUR INSTITUTE OF TECHNOLOGY

for the degree of

ELECTRICAL ENGINEER

June 4th, 1908.

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Dean of the Cultural Studies.

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PREFACE

The object of this thesis is to bring before the minds of its readers the design, installation and operation of a modern automatic electric signalling system for a steam railroad.

An exact copy of the specifications governing material and construction is included. The descriptions of materials and mechanisms are supplemented, as far as possible, by lettered prints and diagrams, in an effort to bring out every detail which will make the construction and operation more clearly understood.

In taking up the electrical circuits and connections in detail, the sole purpose is to impress their great importance upon the minds of the readers, and to show their connection with the terms of the specifications.

The work of installing the system herein described is at the time of this writing in progress, and it is hoped that this paper may arouse the interest of the technical students and others who may chance to read it,

along signalling lines, at least to the extent of visiting this installation and observing the system in actual operation.

E.L.E.

June 4th, 1908.

THE AUTOMATIC ELECTRIC SIGNAL.

The Automatic Electric Signal, as used on steam railroads, is one which has for its operating power, electricity directly under control of the train on the rails. This is accomplished by dividing the track into sections insulated from each other by special insulating rail joints which replace the ordinary fish plates. At one end of each section is placed a battery, the positive side being connected to one rail and the negative side to the other rail. At the other end of this section is placed a magnetic switch or relay, the terminals of its magnetizing coil being connected to the rails. The armature of this relay carries contact points which close when the armature is attracted to the cores and open when the magnetizing force is cut off or considerably reduced. These contact points control the current which operates the electrically driven machanism governing the signal movement.

To insure safety in operation, all signal positions other than those meaning danger, are obtained by the operation of a motor against the force of gravity. The signal arm or blade is also held in these positions by a current in a closed circuit. Any failure or break in this circuit releases the holding mechanism, and the

signal arm or blade returns to the danger position by the force of gravity and remains there until the fault is remedied. These are the fundamental principles on which all automatic signals are operated. There are many appliances operated in conjunction with automatic signals, but these will be taken up in detail in the following pages.

AUTOMATIC ELECTRIC SIGNAL INSTALLATION.

The Automatic Signal System, described in the following pages, is being installed by the Continental Signal Company of Chicago, on the double track main line of the Chicago & Western Indiana Railroad. It extends a distance of ten miles, and embraces nearly all of the complications usually encountered in an installation of this kind. It is carried through six interlocking plants; one drawbridge; across two trolley line crossings; and into an interlocking plant at either end.

The following is a copy of the specifications as submitted by the railroad company:

AUTOMATIC BLOCK SIGNALS: To govern main and double tracks between Hammond Junction and State Line, as shown by diagram dated March 2nd, 1907, which contemplates the use of thirty-five (35) automatic block signals and embraces the interlocking plants at State Street, crossing of [illegible]. & W. I. passenger and freight tracks; Burnside, crossing Illinois Central Railroad; 112th Street, junction South Chicago branch; Calumet drawbridge, swing bridge; Burnham, crossing South Chicago Southern; State Line, railroad crossing and Pullman Junction, junction of C. & [illegible]. I. passenger and freight tracks.

The block signals are to be one arm three position, automatic electric, of the manufacturers' latest pattern, indication as follows: Arm in horizontal position, to show red at night, block ahead occupied; arm at an angle of forty-five (45) degrees to the horizontal, to show green at night, block ahead clear but second block ahead occupied; arm in vertical position, to show white at night, both first and second blocks clear.

SEMI-AUTOMATIC SIGNALS AT INTERLOCKING PLANTS:

The top arm on the home signal shall be semi-automatic electric. Indication given will be the same as at the block signals, except that they shall be controlled by the levers in the interlocking machine.

The circuits shall be arranged so that the signal will be returned to the normal position automatically, and it shall not again become operative until the train has passed the first block signalbeyond the crossing and the lever in the tower has been returned to normal and then reversed.

NORMAL POSITION:

The normal position for the automatic block signal shall be at clear, and, for the semi-automatic signals, shall be at stop position.

The apparatus must be so arranged that, if any appliances used in any way in connection with the signals shall become out of order, the signal affected shall immediately assume and remain in the stop position. This is also to apply to indicators.

HOME SIGNAL AT INTERLOCKING PLANTS:

Two arm signals shall be used for all home signals. Where there is no diverging route, the lower arm shall be fixed for stop position. Where there is a diverging route, the lower arm is not to be semi-automatic.

At State Line, Burnham and 112th Street interlocking plants,the lower arms on home signals are wire connected.

At State Street and Pullman Junction, the lower arm is pipe-connected.

FOUNDATIONS FOR BLOCK SIGNALS:

Suitable concrete foundations shall be built. Top of foundations to be level with top of rail, having four (4, one-inch anchor bolts 36' long, properly built in.

The trunking shall be imbedded in the concrete, to permit wires to be run in signal case.

STORAGE BATTERIES:

Storage batteries, 5 D Chloride Accumulator or its equivalent, shall be provided of sufficient capacity to operate the signals, signal circuit, switch

indicators and tower indicators.

Not less than six cells shall be used in one battery, to operate a signal. Where two signals are directly opposite each other, both signals are to be operated from one battery.

GRAVITY BATTERIES: Gravity batteries shall be used for all track circuits and for charging the storage batteries. At least three cells of gravity batteries must be used to charge one storage cell.

BATTERY WELLS: Circular watertight concrete battery wells shall be provided of approved design; size, 5' x 7' inside measurements. Suitable battery shelving must be provided, and framed so that the nails and screws do not carry the weight of the batteries.

The cover for hatchway must be lined with #24 Galvanized Iron, painted. Provision must be made for locking same. Wires run in battery wells must be carried on suitable wooden or porcelain cleats.

BATTERY CHUTES: Where track batteries can not be put in battery well, cast iron battery chute must be provided.

Chute must be not less than 6' deep and provided with elevator to hold three cells of 6" x 8" gravity battery.

RELAYS: Track relays are to be enclosed type and are not to have less than three (3) points, three (3) front and two (2) back contacts, four (4) ohm resistance.

Line relays are not to have more than three (3) points, three (3) front and two (2) back contacts, thousand (1000) ohm resistance.

Relays to be of the enclosed type.

Wherever possible, relays are to be placed in signal cases; otherwise, cast iron relay boxes with iron pipe post, designed to be bolted to the top of a concrete foundation, must be provided.

BONDING: Two bond wires, No.8 E.B.B. Galvanized, 52" in length, must be used for each joint, securely fastened to the rail with channel pins in center of web rail.

WIRING: Hazard Special Railroad insulation or its equivalent shall be used. No.9 B&S soft drawn copper wire with 5/64" wall rubber insulation, one tape and one braid covering, shall be used for all track connections, track circuits, and for motor circuits. No.9 B&S flexible soft drawn copper wire with 5/64" wall rubber insulation, one tape and one braid covering, shall be used on battery on elevator in battery chute.

No.12 B&S soft drawn copper wire with 5/64" wall rubber insulation, one tape and one braid covering, shall be used from line wire to signal and to other local signal or indicator circuits.

No.16 B&S flexible soft drawn copper lamp cord, with 1/16" wall rubber insulation, one tape and one braid covering, shall be used for all local wiring in signal and relay cases.

The ends fastened to the binding post with jamb nuts must be soldered.

Nothing smaller than No.10 B&S hard drawn copper triple braided weather proof shall be used for line wire.

The signal company to furnish all wire, including line wire.

The line wire is to be put up by the signal company on supports, which will be furnished by the Railroad Company. These supports will include glass insulators.

Ariel cable shall be used from pole line into the tower and crossing tracks. Four (4) spare strands must be provided in each cable.

The strand for common wire must be of No.10 B&S; those for other circuits must be not smaller than No.16 B&S gauge.

All strands must be of copper and have 1/16" wall rubber insulation.

At terminals, suitable cable-box must be provided with a terminal board having slate or porcelain base and brass binding post. All wires leading into this cable-box must be connected to the terminal board and protected with lightning arresters.

All ariel wires must be protected by suitable lightning arresters approved by the Signal Engineer. When placed outside, these arresters must be placed in a waterproof iron case.

Suitable ground connections must be made to the lightning arresters, and must be placed at least ten feet in the ground, or more if necessary.

INSULATING TRACK JOINTS:

Weber insulated joints, 24" long, for A.S.C.E. rail of section 8004, shall be furnished by the Signal Company for all insulation in track.

These joints will be applied to the rail by the Railroad Company.

At places where there is not sufficient room to apply the standard Weber joints, fibre angle plates may be used between the angle bars and rails, and the bolts insulated by means of fibre bushings.

SWITCH AND PIPE INSULATION:

All switch rod and pipe line insulation required to insulate the track through interlocking plants, shall be furnished by the Signal Company.

FOULING POINTS ON SWITCHES AND CROSSOVERS:

Track circuits shall be arranged so that cars inside of tracks must properly clear main tracks before clear signal will be displayed.

On main track crossovers, each switch box shall be arranged to shunt both track circuits.

At Pullman Junction, switches and movable point frogs, as designated on plan, shall shunt track circuits.

SWITCH BOXES:

Switch boxes shall be connected with all switches and so arranged that when a switch is in the wrong position or the point is one-eighth of an inch away from main rail, the signal in rear will be thrown to STOP position.

SWITCH INDICATORS:

Switch indicators of semaphore pattern shall be located at the stands for all switches not operated by interlocking. Resistance - 10.0 ohms.

The indicators must have separate concrete foundations.

The circuit shall be arranged so that the approach of a train will be

indicated at the switch while the train is at least 2000 feet from the signal, which could be affected by opening switch. Setting point to be second signal in the rear.

TRUNKING: Substantial wooden trunking must be provided for all runs of wire on the ground and on telegraph poles to the arms supporting the line wire, and must be of sufficient size to leave unused 25% of the inside space provided.

Trunking crossing tracks, the top of the capping must be one inch below the base of rail.

Trunking must be painted or dipped in good preservative paint.

Outlets from trunking must be made to arise or bootleg constructed in a substantial manner.

Inside corners of trunking must be rounded.

All trunking, with the exception of that placed on poles, must be run on stakes placed every four feet.

Stakes must be of three inch by four inch rough oak, placed at least three feet in the ground.

CONNECTIONS: Copper wire must not be fastened to the rail, but the bond wire connections must be run into the bootleg and copper wire spliced to this, and properly soldered and taped.

Two feet slack copper wire must be left at each end of trunking.

JOINTS AND SPLICES: All joints must be soldered and made by dipping wire into or pouring on the melted solder, wherever practical. Wires at joints must be made in form of regular line wire splice, with turns spaced 1/64" apart. Joints must be thoroughly washed, dried, painted with P&B compound, and must be wrapped with Okonite tape heated and pressed down. Care must be used not to heat taping to injure the quality of material. A coating of P&B compound must be put on over the Okonite tape. It must then be wrapped with not less than two layers of Grimshaw or some other equally good cloth tape.

No splice shall be put in wires leading from track to track relays, or from track to track battery.

No splice shall be put in wire crossing the track.

Splice in line wire and ground wire lines must be avoided as much as possible.

All splices and joints must be soldered and taped as specified.

TAGGING: All wires in relay, signal, lightning arrester cases, and on electric locks, must be tagged with sheet fibre discs fastened to the wires with tarred marlin, marked with number and letter to indicate the operating condition, resulting from current being sent through the wires.

LOCKS: All switch boxes, mechanism cases, etc., will be provided with Railroad Company's standard padlocks, furnished by the Railroad Company.

PAINTING: All signal poles, signal pole fittings and ground connections must be painted black.

No paint shall be applied to the outside surface in freezing weather, nor shall any surface be painted unless same is cleaned and dried, or until the previous coat has thoroughly dried. Surface covered with rust, grease, dirt or other foreign substance, must be thoroughly cleaned by scraping or other suitable method.

SEMAPHORE BLADES: Semaphore blades must be 4' 5" in length and painted the Railroad Company standard.

LAMPS: No. 3 Dressel semaphore lamp must be furnished for all signal arms; back side of lamp must be provided with 1/2' peep hole.

ELECTRIC LOCKS: At the interlocking plants, electric locks, resistance 100 ohms, must be applied to the levers operating the semi-automatic home signals, and the circuits so arranged that the signal lever shall be locked latch up, with lever normal when home signal lever is reversed and an approaching train enters track section 1000 feet in rear of the distant signal.

The signal lever shall remain locked, latch up, until the train has passed the home signal, provided the distant signal has resumed the caution and the home signal the normal position.

Electric locks to be of type shown in Union Switch & Signal Company's catalogue, Section 11, Plate 1110-A.

The Signal Company shall provide the locking shafts in machine necessary for the attachments to operate the electric lock.

HAND RELEASE: In connection with each electric lock, an electric hand release shall be furnished and so arranged that the electric lock can be released in one minute, provided the distant signal has resumed caution and the home signal the normal position.

Hand release to be of type as shown in Union Switch & Signal Company's Electro-Pneumatic catalogue, Plate 0915, Fig. A.

TOWER INDICATORS: In connection with the semi-automatic home signals at State Line; Burnham; Calumet Drawbridge; 112th Street; Burnside and State Street interlocking plants; indicators of the semaphore type with three points, 1000 ohms resistance, enclosed in iron case, shall be provided and placed in the tower to be used as stick relay control for the semi-automatic home signals, and to indicate that the track section in advance of home signal is occupied by train.

TOWER WIRING: All wiring inside the tower must be run on porcelain cleats or knobs.

DERAIL CIRCUITS: In connection with the circuits on home signals at interlocking plants, with the exception of Pullman Junction and on the mechanical home signal at Hammond Junction and State Line, the relays controlling the slot and motor circuits shall be controlled by an independent circuit and battery.

The circuit shall be opened and closed through a switch box connected with the facing point derail.

TROLLEY CROSSINGS: At trolley crossings, the track circuits shall be arranged so that the batteries feed from the crossings in all cases.

SPECIAL: At Hammond Junction, on lever operating the top arm on mechanical home signal, electric lock and slow hand release shall be provided.

At State Line, on lever operating the top arm on mechanical home signal (marked B on plan) electric lock and slow hand release shall be provided.

BRIDGE COUPLERS: At Calumet Drawbridge, suitable electric bridge couplers shall be provided to control the circuit passing through the rails over the bridge.

Plans of the electric bridge coupler and of the circuits proposed to be used in connection with the block system shall be submitted with the proposal, for the Engineer's approval.

PLANS: Signal circuits to be same as Pennsylvania Lines West, in all respects not noted in above specifications.

Plans on catalogue, illustrating the type of signal, indicators, switch boxes, battery wells, battery chutes, relays, boxes, lightning arrestors, and storage batteries, shall be submitted with the proposal.

All work must be done under the supervision and to the satisfaction of the Signal Engineer of the Railroad Company.

The foreman to install the plant must be satisfactory to the Railroad Company.

In order that these specifications may be clearly understood, each clause will be taken up and explained and supplemented by a description of the material or mechanism directly connected with it.

A copy of the plan dated March 2nd, 1907, referred to in the first paragraph of the specifications, is herein inserted as Fig. 1. This print shows the complete layout of tracks and the location of the signals to scale. Each track is represented by a single line, and the arrows added show the direction of traffic. The signal system

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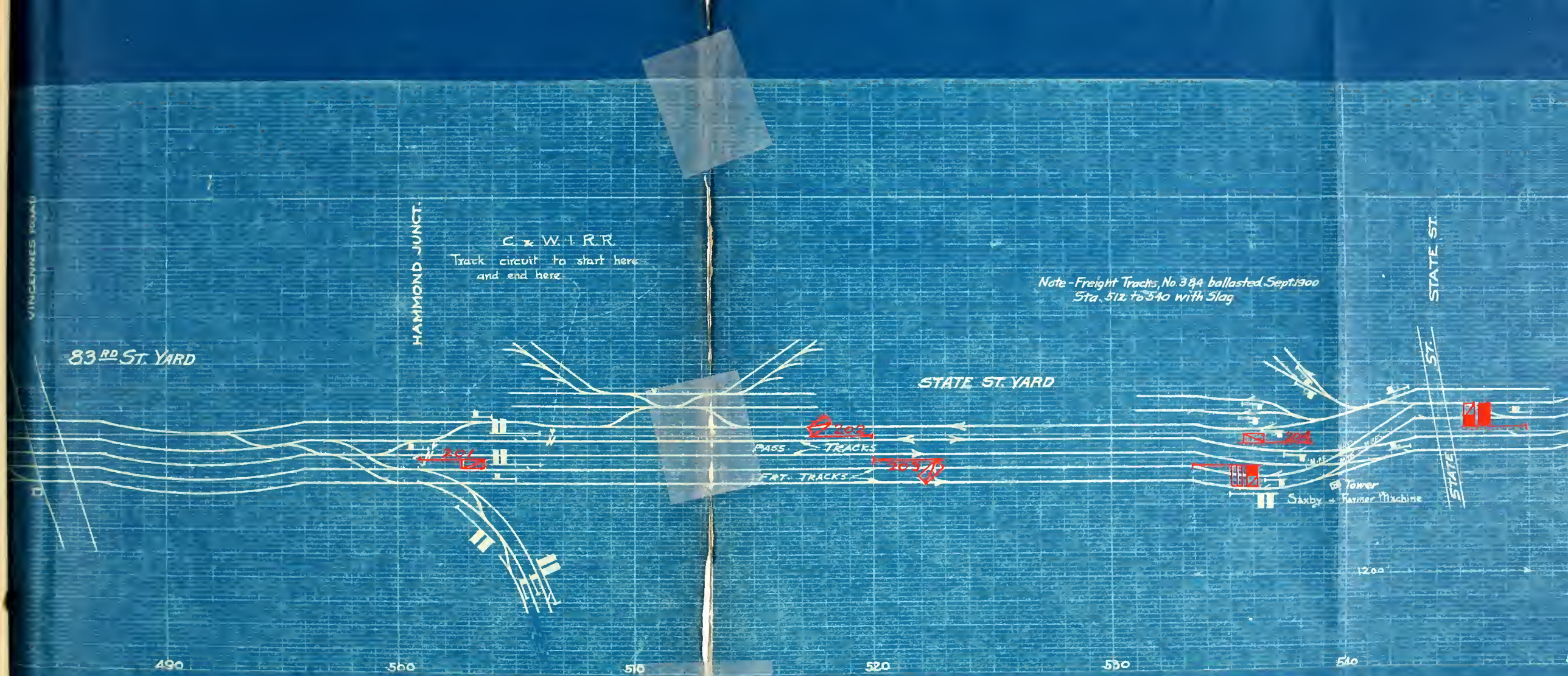
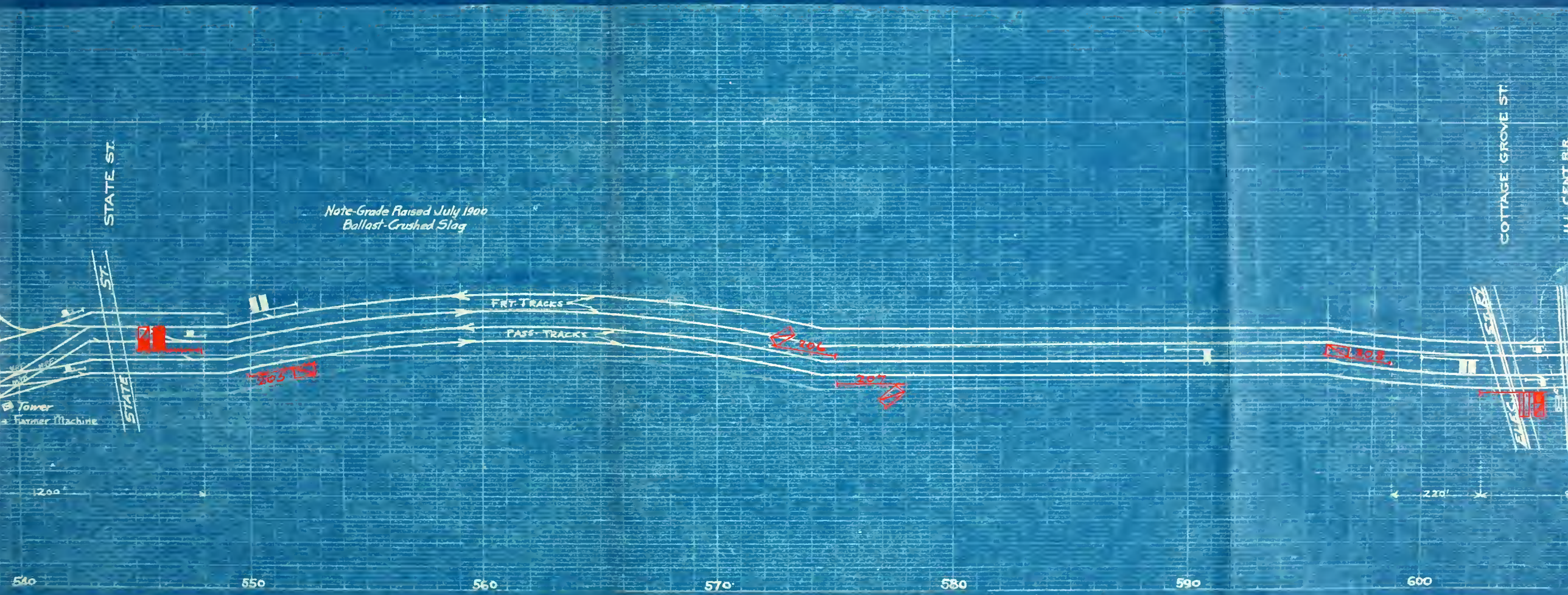
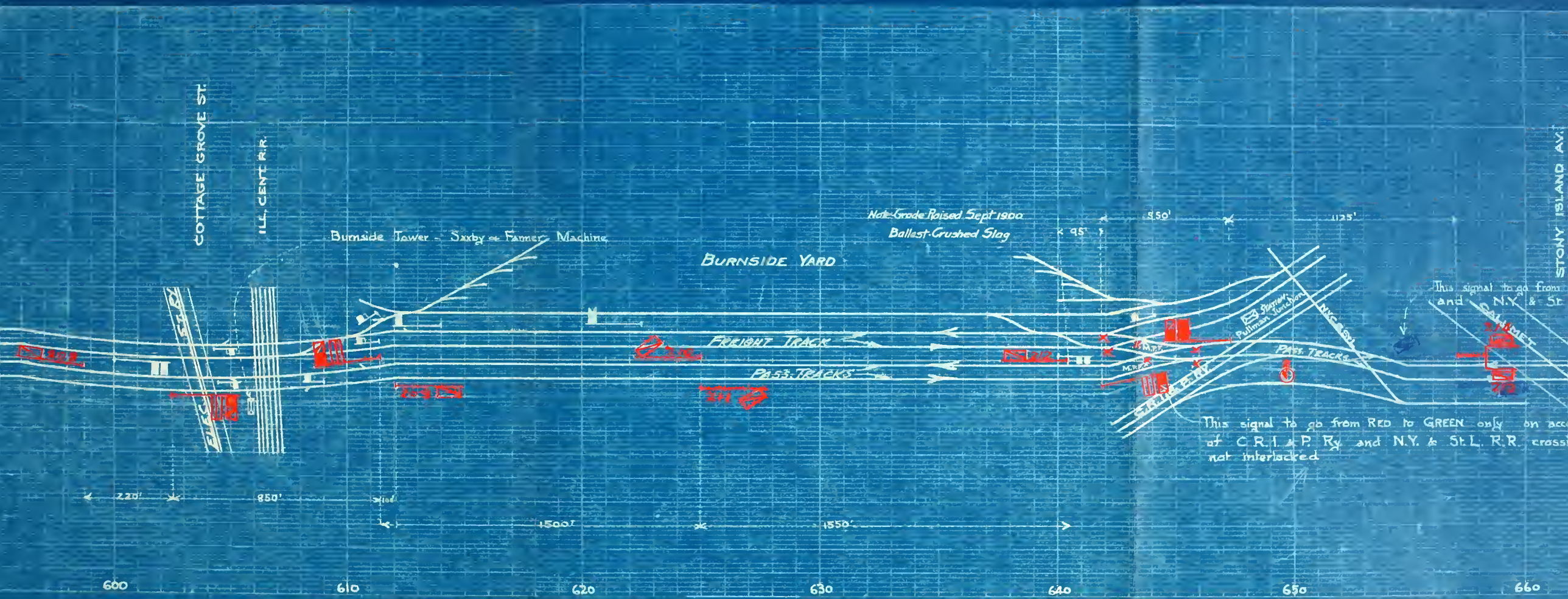
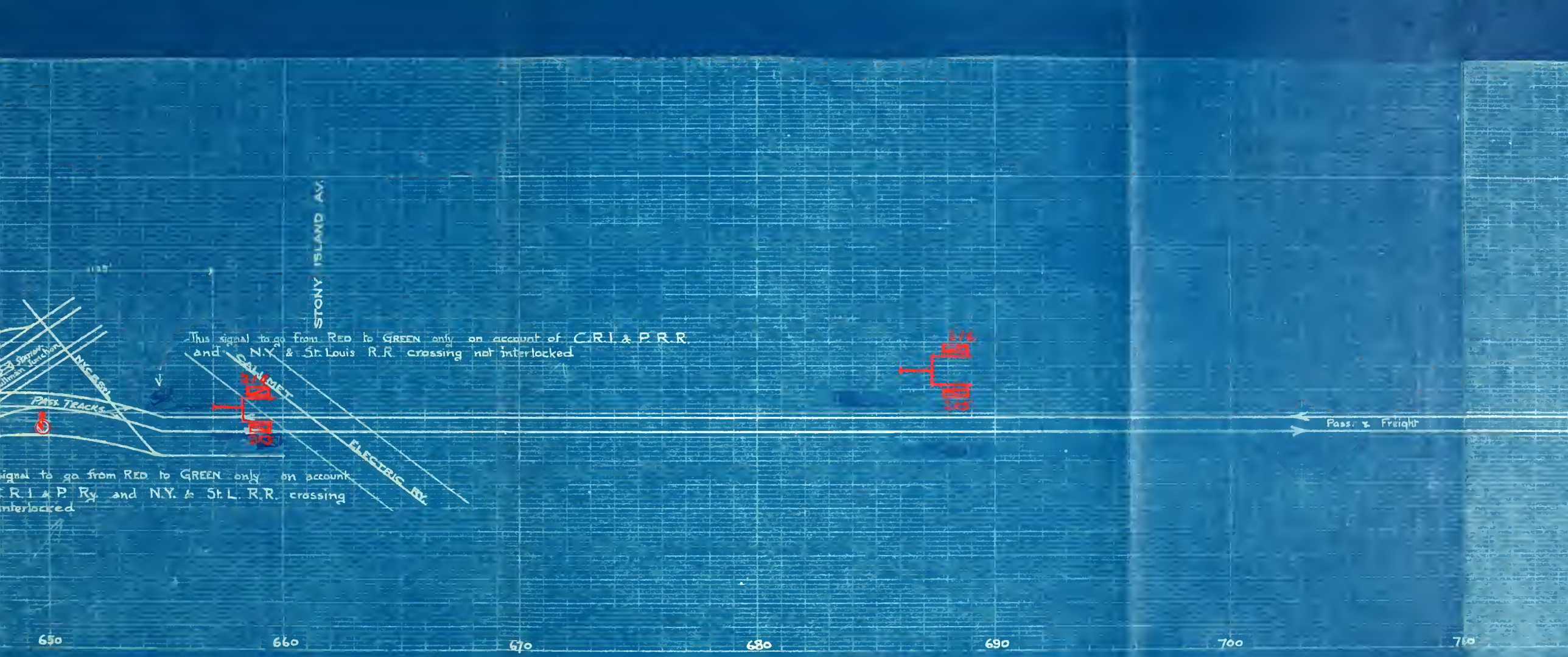
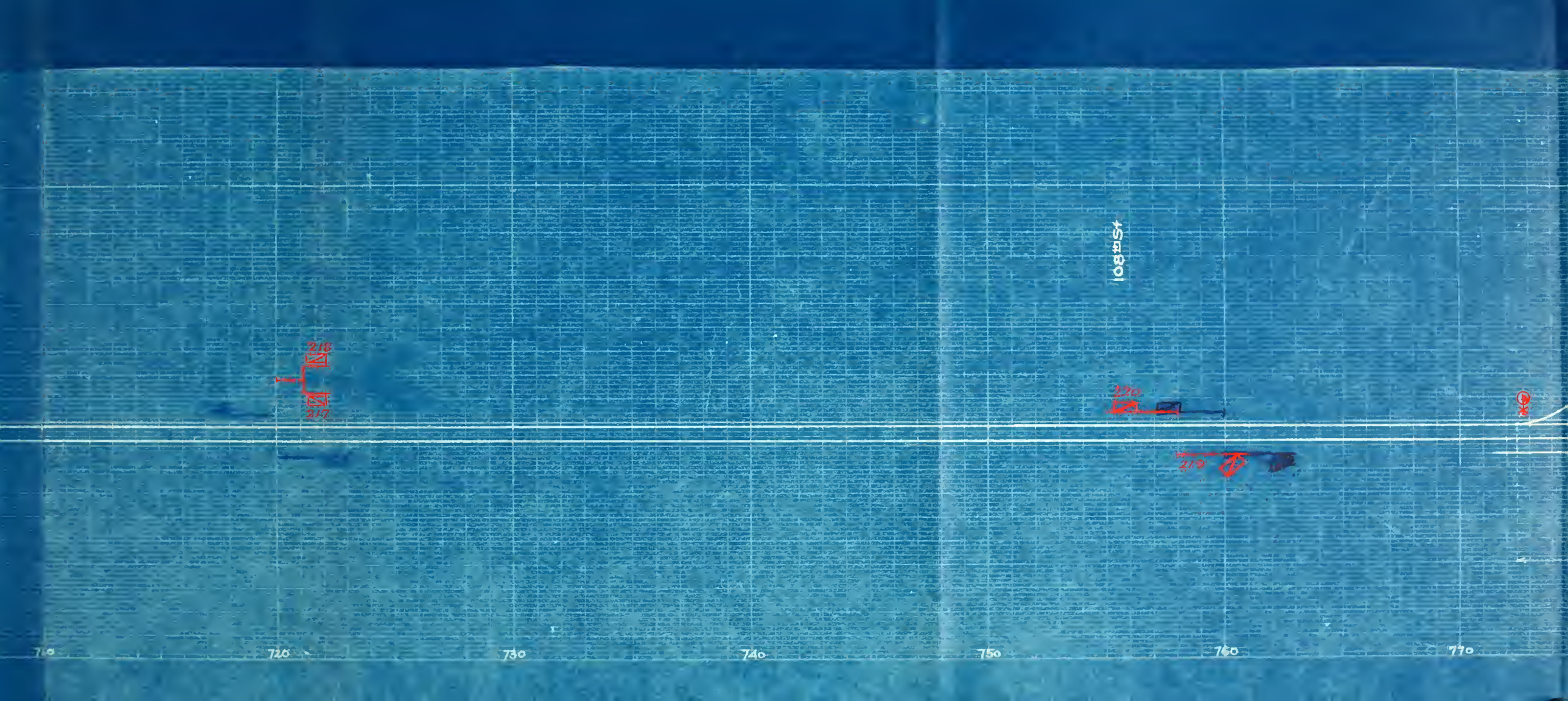

VINCENNES ROAD
HAMMOND JUNCT.
C. & W. I. R.R.
Track circuit to start here and end here
83RD ST. YARD
STATE ST. YARD
Note - Freight Tracks, No. 3 & 4 ballasted Sept. 1900 Sta. 512 to 540 with Slag
PASS TRACKS
FRT. TRACKS
Tower
Staxby & Farmer Machine
STATE ST.
490
500
510
520
530
540

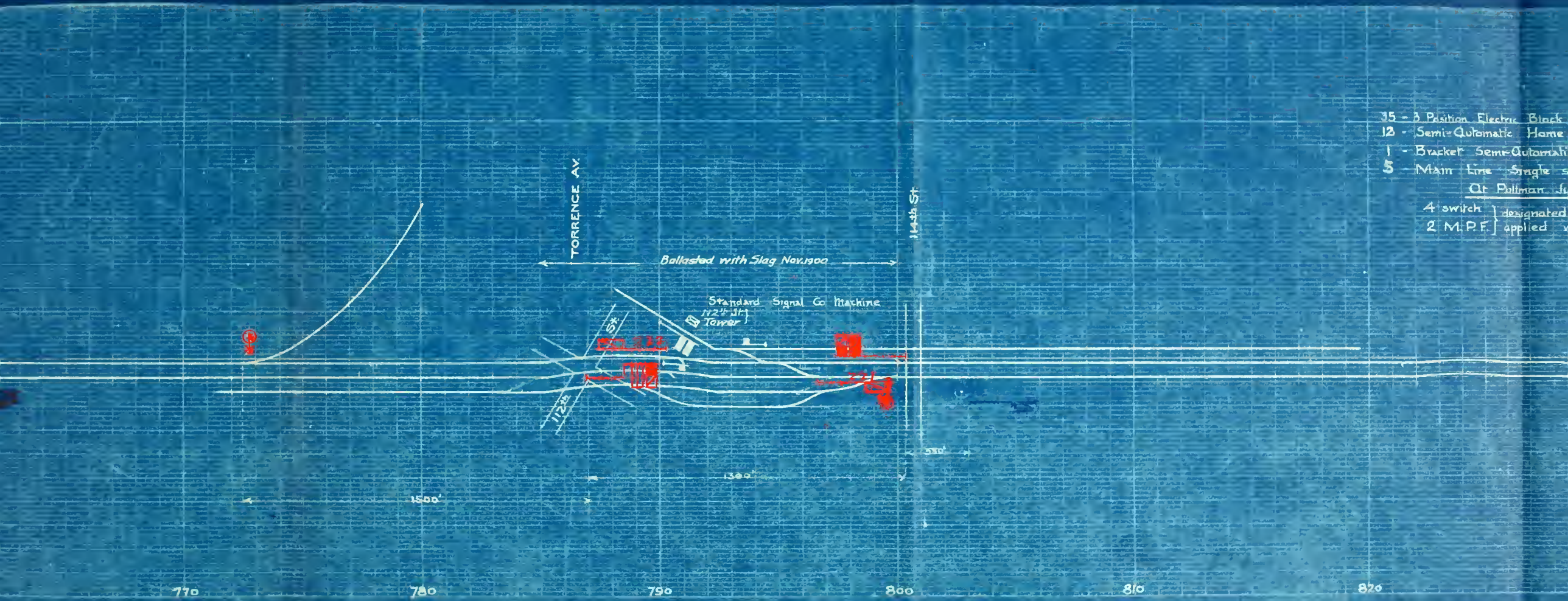
Fig 1


STATE ST.
57.
STATE
Note-Grade Raised July 1906
Ballast-Crushed Slag
FRT. TRACKS
PASS. TRACKS
303
301
307
303
Tower
Farmer Machine
1200'
220'
COTTAGE GROVE ST.
540
550
560
570
580
590
600


COTTAGE GROVE ST.
ILL. CENT. R.R.
Burnside Tower - Saxby & Farmer Machine
Nat. Grade Raised Sept. 1900
Ballast-Crushed Slag
BURNSIDE YARD
FREIGHT TRACK
PASS. TRACKS
PASS. TRACKS
Stanton Pullman Yards
M.P.R.R.
N.Y.C. & St.L.
STONY ISLAND AV.
This signal to go from
and N.Y. & St.
This signal to go from RED to GREEN only on acc
at C.R.I. & P. Ry. and N.Y. & St.L. R.R. cross
not interlocked
220'
850'
1500'
1550'
1125'
600
610
620
630
640
650
660


STONY ISLAND AV.
Thus signal to go from RED to GREEN only on account of C.R.I. & P.R.R.
and N.Y. & St. Louis R.R. crossing not interlocked
CABINET
PASS. TRACKS
ELECTRIC RY.
Pass. & Freight
signal to go from RED to GREEN only on account
C.R.I. & P. Ry. and N.Y. & St.L. R.R. crossing
interlocked
650
660
670
680
690
700
710


218
217
220
219
108+51
710
720
730
740
750
760
770



35 - 3 Position Electric Block
12 - Semi-Automatic Home
1 - Bracket Semi-Automati
5 - Main Line Single
At Pullman Ju
4 switch } designated
2 M.P.F. } applied

35 - 3 Position Electric Block signals (C on 5 bracket poles :-
12 - Semi-Automatic Home "
1 - Bracket Semi-Automatic Home signal
5 - Main Line Single switches
At Pullman Junction
4 switch } designated thus x shall be
2 M.P.F. } applied with switch boxes.

Union Switch & Signal Co.
Ground Plan - Dr. 1766 9-
Locking Sheet - Gr. 961 12-
Dog Sheet - A 1258 10

CALUMET RIVER DRAW-BRIDGE

1292'
740'
377'10"
160'
582'
202'10"
Tower
22.5
26°
Taken on centre of bridge

820 830 840 850 860 870 880

Union Switch & Signal Co. Saxby & Farmer Machine
Ground Plan - C. 1766 9-16-1897
Locking Sheet - G. 961 12-6 "
Dog Sheet - A 1258 10-5 "

1292'
240'
377 1/3"

TOWER

240'

Taken on centre of bridge

880 890 900 910 920 930

136th ST.
HOWARD
AVE.
HEGEWISCH
BURNHAM
CENTER ST.
NOTE
3 Positio
3 "
3 "
All swi
And swi
All swi
at swit
Saxby & Farmer Machine
930
940
950
960
970
980
990

C. & W. I. R.R.

Electric Semaphore Signals, Automatic and Semi-Automatic from

HAMMOND JUNCTION TO STATE LINE TOWER

Scale:- 1 inch = 400 Ft.

10·3 Miles double track

March 2nd 1907.

CENTER ST.

NOTE

3 Position Electric Block Signal

3 " " Semi-Automatic lower arm operated mechanically

3 " " " " " fixed "

All switches marked thus ? indicate that a switch indicator and switch-box shall be placed at the switch.

All switches marked thus X indicate that a switch-box shall be placed at switch.

E. J. & E. YARD

C. & W. I. EAST SIDE TRACK

C. & W. I. WEST SIDE TRACK

This to go clear when top arm on Semi-Automatic Home Signal 'A' and Mechanical Home Signal B in advance are clear.

C. & W. I. R.R.

Track circuit to start here and end here.

STATE LINE NATIONAL MACHINE

TOWER

A

B

536'

765'

990

1000

1010

1020

1030

1040

starts at signal #201, on the southbound passenger track and at signal #48 on the northbound track. The print, as a whole, is self-explanatory, with the exception of a few points which will be taken up.

At Pullman Junction, the freight tracks and passenger tracks join, there being but two tracks south of this point. These two tracks cross the tracks of the Baltimore & Ohio, and also those of the Nickel Plate Railroad. These two crossings are not interlocked but the movement of trains is controlled by gates. The switches and movable point frogs of the junction, however, are in a sense interlocked. The signals alone are controlled by levers in the tower, but all switches and movable point frogs are thrown by hand; and, on account of locks introduced into the pipe lines governing the signals, insure that they are correctly set before a signal can be cleared. All trains are required to stop on account of uninterlocked crossings, and, since these crossings are in the block governed by signal #1 southbound and signal #214 northbound, the indications of these two signals are restricted to the 45 degree or caution position.

It will be noted that signals 213 and 214, signals 215 and 216, and signals 217 and 218, are placed on a single pole on the same side of the track. These poles are known as bracket poles and the reason for their use at these points is that the Nickel Plate road, after crossing the C. & W. I. at Pullman Junction, runs

parallel to it as far as signal 219 shown. The tracks are so close together that sufficient clearance for the ordinary straight pole is not given, and the three signals affected were necessarily placed on the wrong side of the track. Signals 213, 215 and 217 govern the southbound track while signals 214, 216 and 218 govern the northbound track. The construction of the different types of poles will be shown later.

It will also be noted that the semi-automatic signal, #19, at the interlocker at 112th Street, is placed on an offset pole. This pole is of the same construction as those above and is used at this point so as to place the signal out over the track, as the view from the north is obstructed by a high board fence running close to the track.

The purpose of the switch boxes designated on the plan is to insure that switches are set in the correct position for the main track. If a switch be set in the open position, its switch box interferes with the circuits of the signal governing this switch in such a manner that it is thrown to the stop or danger position, in which it remains until the switch is properly set.

The purpose of the switch indicator designated is to indicate to a person at the switch whether he may safely open it without interfering with an approaching train. The manner in which this is done will be explained when the signal circuits are taken up.

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Fig 2

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Fig. 3, page 19, shows a side and front elevation of a completely assembled block signal on its foundation. Referring to letters, a is the concrete foundation 22" square at the top, 32" square at the bottom and 5' deep. Imbedded in the concrete, are the four foundation bolts, bb, of 1" round iron, 36" long, with a hook of 4" length on the end.

The mechanism case, c, is held to the foundation by the four hook bolts. This case contains the operating mechanism. The doors, d, allow access on two sides. The latches, e, are arranged with eccentric lugs which press the doors tightly against the case. Rubber tube gaskets are used, which make the case water tight. For ventilating purposes, a small opening, with overhanging covers, is provided at f.

The pole proper sets upon the mechanism case and is held by the four bolts, g. The base, h, is cast iron. The pole, i, is placed in it and lead filled in to make it secure and water tight.

The bearing casting, j, sets down over the top of the pole and is held in place by set screws. This bearing contains the connections with the mechanism in the case at the base. The shaft, k, turns in phosphor bronze bearings and is driven by connections within (This will be explained later in detail.). The protruding end is squared to receive the casting, l, commonly known as the 'spectacle casting." It is held upon the squared portion by a nut and cotter on the outside. This spectacle cast-

ing carries the blade, m, which is of wood. The spectacle casting, with the blade, is free to move with the shaft, k. Their movement is limited by stops to 90 degrees. As shown in the figure, the blade is horizontal. It can not move any higher but can be pulled downward through 90 degrees, or vertical when it becomes parallel to the pole. The bracket, n, is used to support a lamp, which is located behind the openings, o, p and q, in the spectacle casting. That is, in the horizontal or position shown, the light would be seen through the opening, o; the lamp being stationary, if the blade is moved downward 45 degrees, the light shows through opening, p, while with the blade in the vertical position, the light shows through opening, q. The indications specified are given by the blade by day and the light by night. The top of the pole is closed by the casting, r, called the pinnacle casting. This makes a watertight pole and gives it a finished appearance. Access to the top of the pole is obtained by the ladder, s, held in place by the braces, t, and the cast iron foundation, u.

Referring again to the indications, opening o, in spectacle casting l, will carry a red glass; opening p will carry a green glass, and opening q is left entirely open. Thus, with blade in horizontal position, the light behind the red glass in o would show red, indicating block ahead occupied; with blade in 45 degree position, the light would show green, indicating block ahead unoccupied but second block ahead occupied; and with blade in vertical

position, the light would show white, indicating first and second blocks unoccupied or clear. A block may be defined as that section of track between two consecutive signals.

Blade, m, with spectacle casting, l, is rotated about shaft, K, by supplying current to the motor driving the mechanism at the bottom of the pole. They may be stopped either at 45 degrees or 90 degrees, by cutting off the current from the motor. The blade, however, is held after the motor is cut out by the current either in the 45 degree or 90 degree position. If this current be cut off in any way, the weight of casting, l, is sufficient to return it with blade to the horizontal position. This position is also known as the stop or danger indication, so that failure of any part will cause gravity to place the spectacle casting and blade in the danger position, which means safety for the train whose engineer heeds it.

The semi-automatic signals at interlocking plants are the same as the automatic signals, with the exception that they are under the combined control of the train and the leverman in the interlocking tower. That is, as far as the train on the track is concerned, they operate like the other signals, but it is necessary for the leverman in the tower to close the circuit, which will cause the motor to pull the blade down from the horizontal position.

In order to show to the enginemen the difference between an automatic signal and a semi-automatic signal,

a second arm is placed on the same pole six feet below the semi automatic arm. The semi-automatic arm, therefore, is the top arm on the pole, and governs movements on the main track through the interlocking plant. If there are switches in the interlocking plant over which movements may be made from the main track, then the lower arm governs such movements, and is controlled by a mechanical connection to the lever in tower. If no such movements are possible, then the lower arm is fixed in the horizontal position, and merely shows the function of the semi-automatic arm.

The normal position of a signal may be defined as that position in which a signal should stand if no train be considered. Thus the automatic signals stand at 90 degrees, indicating clear, while the semi-automatic signals stand at horizontal or stop position.

The top bearing casting, referred to in the general description of the signal pole, is shown in two figures Nos. 6 and 7. Fig. 6 shows a side elevation partially broken away, disclosing the working parts within. Fig. 7 shows a front elevation with a half section through the center of the semaphore shaft. Referring to both figures, pages 24 and 25, the segmental sheave, a, has a square hub, b, which works freely between the bearing bosses, c, and d, with no unnecessary end play. The part of the shaft, e, passing through the hub, b, is square so that the shaft and sheave must turn as one. A short length of bicycle chain, f, is secured to the upper end of the

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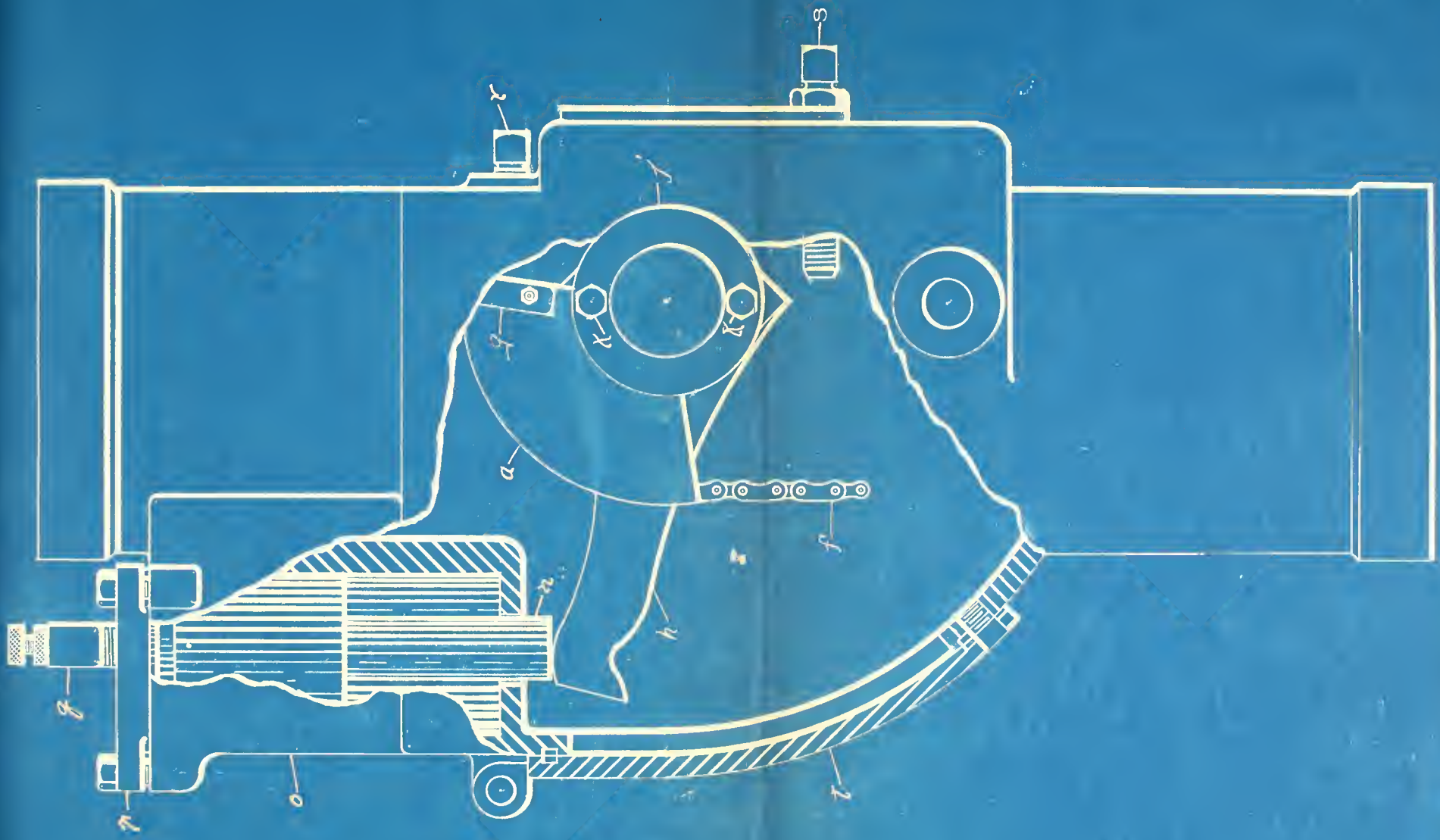

Fig 6

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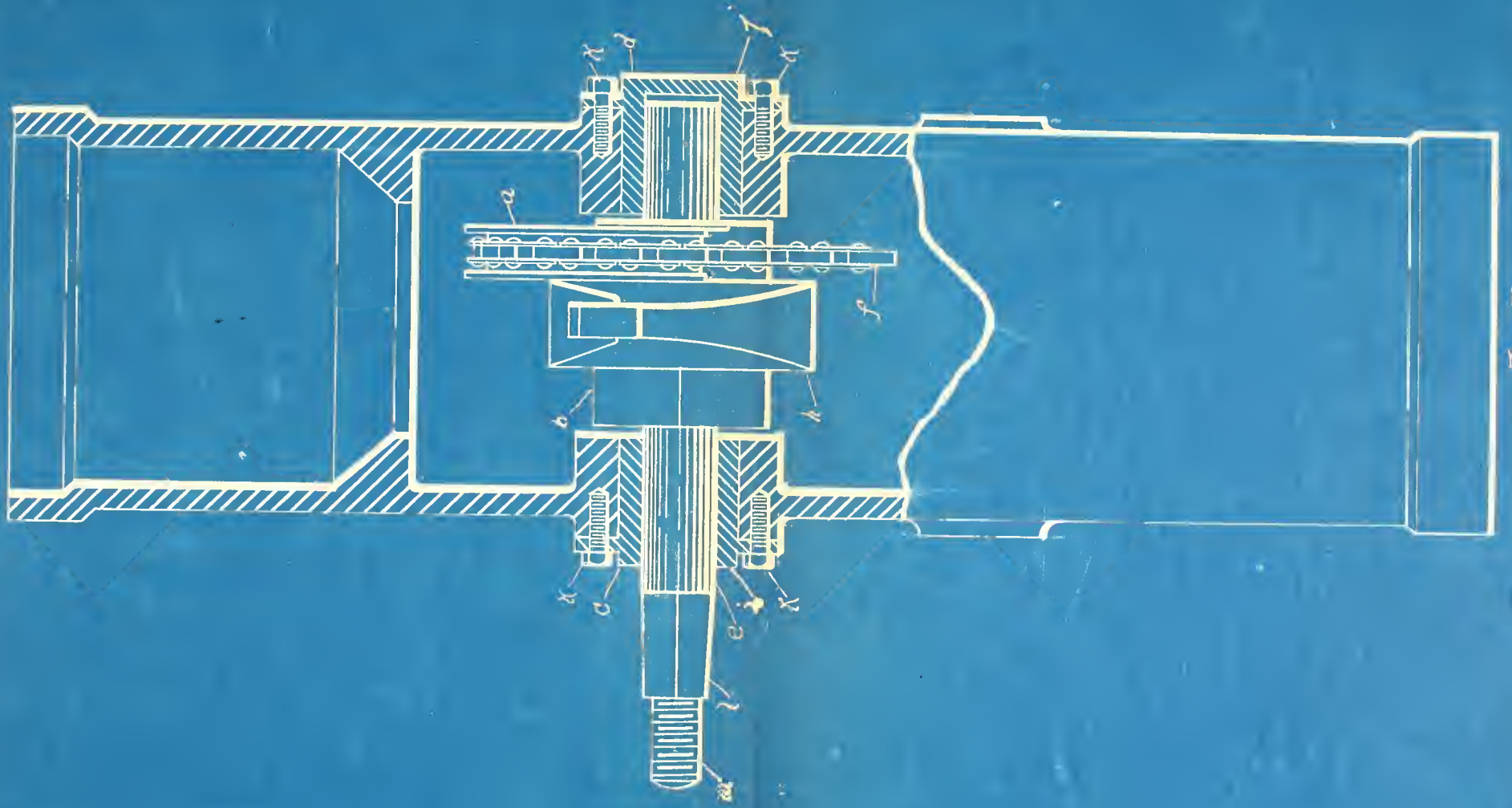
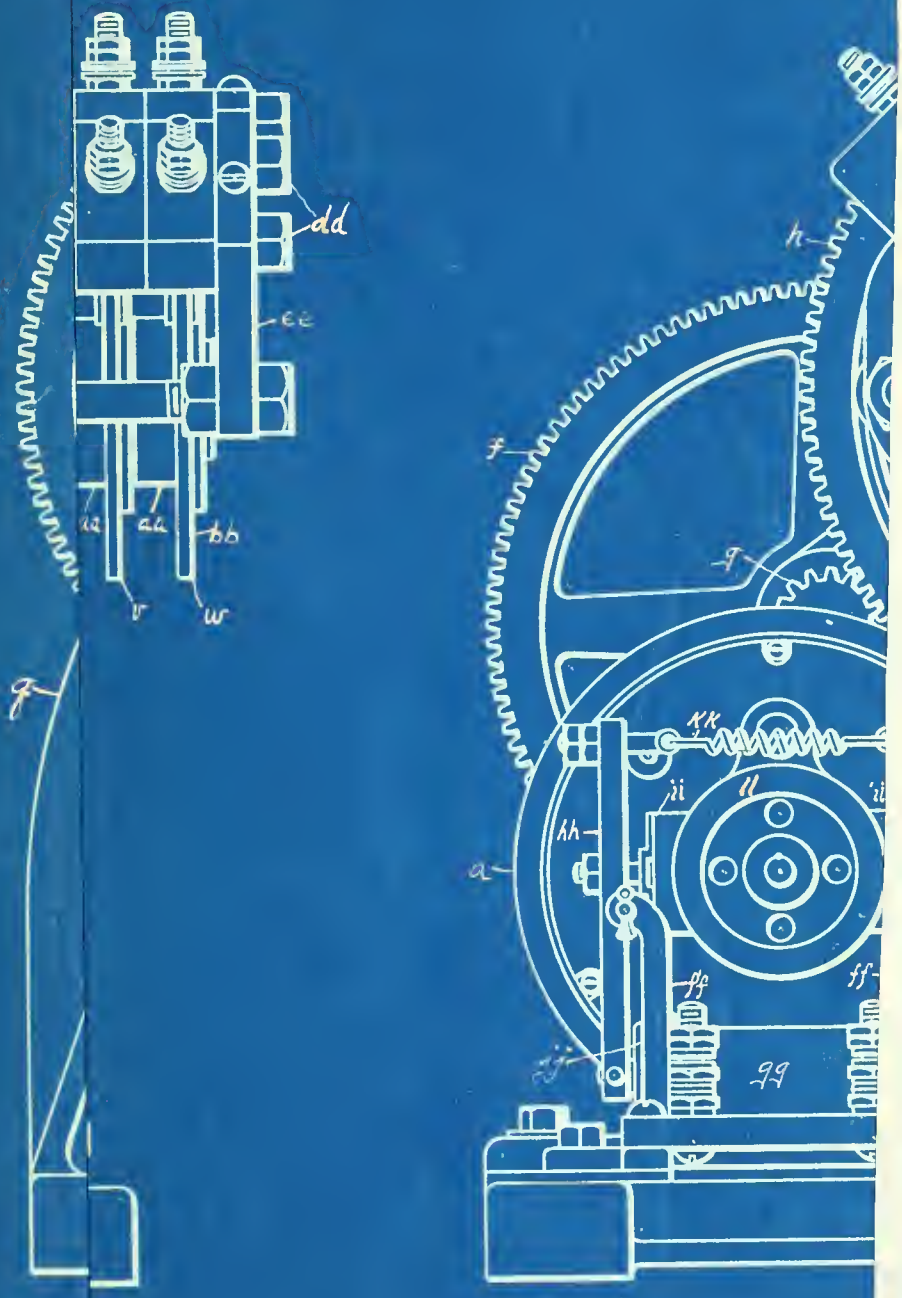


Fig 7

sheave groove by the lugs, g, on either side. To this chain at either end is fastened the wire which connects with a similar chain upon the driving drum of the mechanism. Upon the square hub of sheave, a, is fitted the buffer arm, h, which also must move with the sheave and shaft. The bearing bosses are bushed with the phosphor-bronze bushings, i, and j, held in place by the cap screws, k. The part of the shaft projecting is squared for a short length, l, this squared portion being tapered from 3/4" at the small end to 7/8" at the large end. The part, m, is threaded for a standard 3/4" nut. As stated above, the spectacle casting is fitted to the square shaft, l, and held in place by a nut on the end, m. Referring especially to Fig. 6, page 24, the buffer crank, h, acts against the piston, n, of the dashpot, o. The dashpot is open only at the top and covered by the cap, p, which is pulled down upon a gasket by three cap screws, making an airtight joint. Into the top of the cap is screwed the check valve, q, which is adjustable and acts in such a manner that when piston, n, drops, air will be freely admitted into the cylinder; but, when the force of the arm, h, is thrown upward against the piston, air is allowed to escape very slowly, thus checking the movement of the arm, h. The upward movement of the arm and segment is adjusted by the screw, r, which is screwed into the body of the casting and strikes against the segment, a. The downward movement is adjusted by the screw, s, which strikes

against the lower side of the sheave. These screws are adjusted when the spectacle casting is in place. Screw, r, permits blade to rise until it is horizontal, while screw, s, allows blade to be pulled down it is vertical.

Considering the blade and spectacle casting in place, the parts of the top casting operate as follows: On account of the weight of the spectacle casting, the parts will take the position as shown in Fig. 6, i.e., the blade horizontal, the sheave resting against the stop screw, r, and the buffer arm, h, holding piston, n, at the top of the cylinder. Now, if a downward force is applied to the lower end of the chain, f, the sheave, a, rotates, driving the shaft, e, with spectacle casting and blade, and the buffer arm, h. The piston, n, of its own weight follows the arm, h, to the lower end of the cylinder, air being freely admitted to the top by the valve, q. If the force be released at any point of the stroke, the weight of the spectacle casting returns the parts quickly to the position shown until the buffer arm again strikes the piston, n, compressing the air in the top of the cylinder, which checks the heavy weight and allows it to sink easily into its position against stop screw, r, as the valve, q, allows the air to escape slowly from the cylinder. This is the operation for any position between the limits of the stop screws, r and s. Access for oil and repairs is made through the door, t, which is held firmly against a rubber gasket by a screw at its bottom.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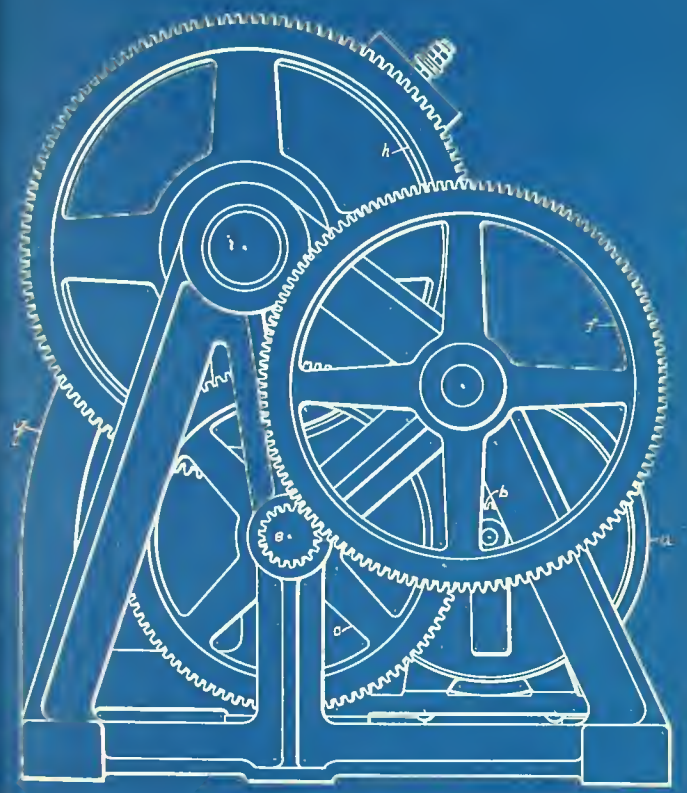

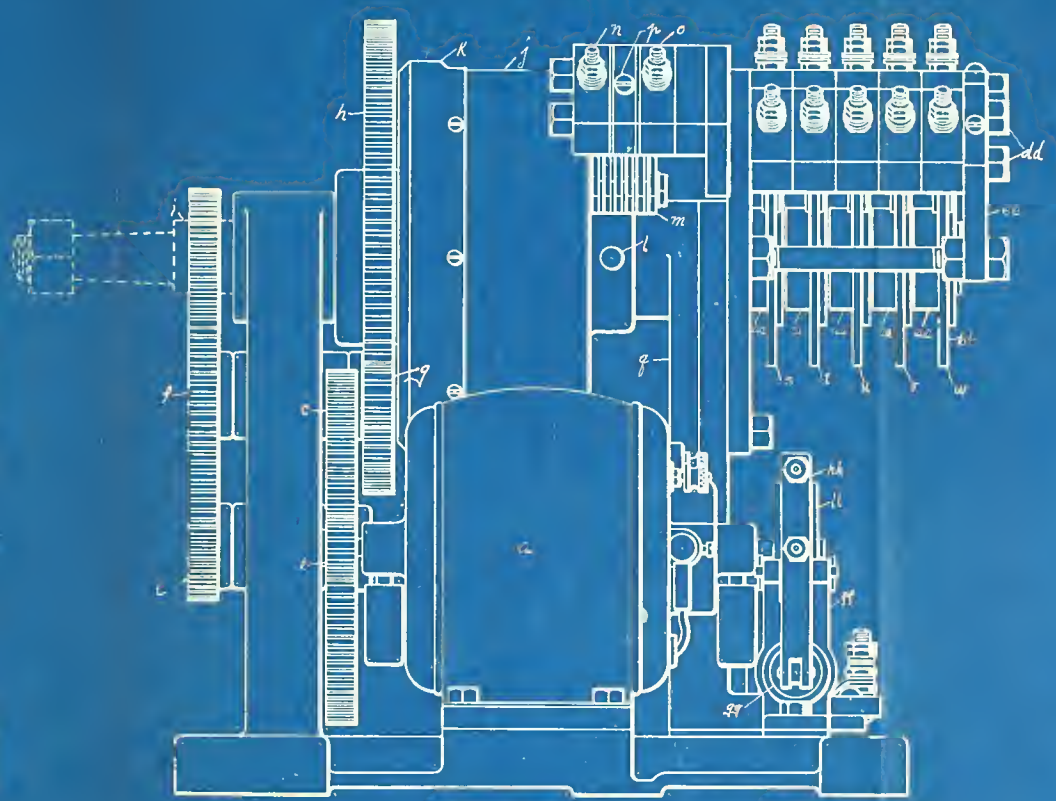

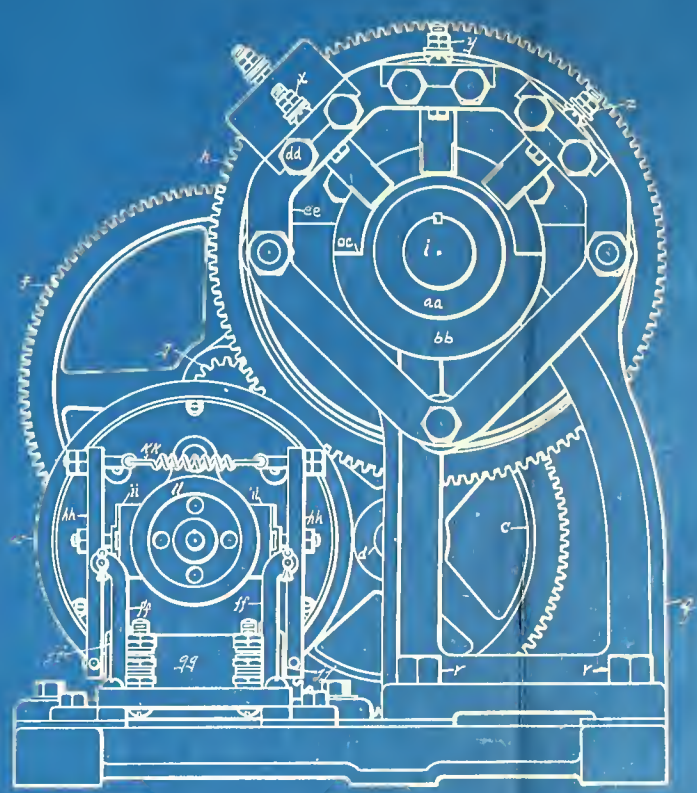

Fig 3

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The operating mechanism for both automatic and semi-automatic signals is shown in Fig. 3, page 28. Three views of the mechanism are shown, i.e., both ends and one side elevation. It consists of a motor; a train of gears; a magnetic clutch; a magnetic brake; and a circuit controller. The motor is shown at a. It is series wound 1/20 H.P. at 11 volts and 1200 R.P.M. It is entirely enclosed and is practically watertight. The commutator is covered with a glass cover so that it can be inspected without opening. The brushes are radial and made of rolled copper gauze. The train of gears consists of the motor pinion, b, of 1" pitch diameter, and 20 diametral pitch. This pinion meshes with a 6" phosphor-bronze gear, c, of 1/2" face. This 6" gear drives shaft, d, which is 3/4" in diameter and has a 1" pinion, e, of 1/2" face and 16 diametral pitch cut from one piece. This shaft runs in a single phosphor-bronze bearing pressed into the frame. Meshing with the intermediate pinion is the 7" phosphor-bronze gear, f, which in turn drives a 3/4" shaft in a phosphor-bronze bearing, having the main driving pinion, g, of 1" pitch diameter and 16 diametral pitch cut upon it. This main driving pinion drives the 8" gear, h, which runs upon a projection of the phosphor-bronze bushing pressed into the frame as a bearing for the main shaft shown at i. The 8" gear, h, drives the armature of the magnetic clutch, j, by projections on its hub. This affords a positive drive, but without rigid connection, leaving the armature free to adjust itself horizontally against

the face of the clutch. This armature is hidden by the brass shield, k, which is attached to clutch, j, and projects out over the armature so as to protect it from dirt. The shield, however, does not touch the armature at any point. The armature and clutch present perfectly flat services to each other.

The clutch, j, is simply an ironclad magnet. It is made of Norway iron. It is 6 1/2" outside diameter and bored to fit the 1-1/[illegible]" shaft, i, to which it is rigidly connected by the taper pin, l. The diameter of the inner pole is 2-7/8", while the inside diameter of the outer pole is 5-3/4". The winding space is bored to a depth of 2-1/8", leaving a back or yoke 1/2" thick connecting the inner and outer poles. This clutch contains a double winding; one consisting of a coil of 88 turns of #12 B&S gauge double cotton covered wire; the other, 6700 turns of #27 B&S single silk covered copper wire. Connections to these coils are made through the slip rings shown at m. There are three of these; one, making connection to one terminal of the #27 coil; one, connecting with one terminal of the #12 coil; and the third affording a common connection for the remaining terminal of both coils. These are respectively reached through the brushes, n, o and p. The coils are so arranged as to produce the same magnetic polarity when current is passed through them, so that when energized at the same time their magnetic effects are combined.

The shaft, i, extends backward through the bracket bearing, q, which is fixed to the frame by the cap screws, r, and carries the movable disks, s, t, u, v and w, which make up a part of the circuit controller. The stationary brushes are arranged in three rows 45 degrees apart, shown at x, y and z. The disks of the circuit controller consist of a cast iron hub, aa, keyed to shaft, i; the fibre disc, bb, fixed to hub, aa, carrying on each side an 1800 phosphor-bronze segment, cc, riveted together through the fibre. Each of the contact brushes at a, x, y and z, is constructed in a horseshoe shape so that it springs down over the phosphor-bronze segments and fibre disks, making contact when on the phosphor-bronze segments, and breaking contact when segments pass from it. Wire connections are made to these brushes by means of the binding posts which hold the brushes in place. Circuits are made between brushes in one row and brushes in another, which make contact on the same disk as the shaft, i, turns. These brushes are units and may be arranged in any manner desired. They are held in place by the long cap screws, dd, which pass through the fibre insulators and screw into the brass bracket, ee, fixed to the bracket, q. Any row of brushes may be removed by unscrewing two of these cap screws and lifting them out.

The magnetic brake is shown at the back of the motor. The two brass standards, ff, are fitted over the ends of the magnet and carry the arms, hh, to which are attached the adjustable swiveled brake shoes, ii. To the lower

end of each of the brake arms is attached circular armature, jj, while the upper ends are connected by the tension spring, kk. The magnet, gg, is also of the ironclad type, made by winding 50 turns of #14 D.C. covered wire on a 3/8 iron core, and placing inside of 1" iron pipe. The core and pipe project slightly beyond the brass supports at each end. This brake is operated in series with the motor so that when the current is supplied to the motor, the armatures on the brake arms are attracted to the core and the brake shoes, ii, are pulled away from the brake wheel, ll, on motor shaft against the force of the spring, kk, and motor armature is released. When the current is again cut off, the brake armatures are released and the spring, kk, causes the brake shoes to again clamp the brake wheel, holding the motor armature stationary.

To sum up the operation of this mechanism, the brake coil and #12 wire coil of the clutch are connected in series with the motor, while the #27 wire coil of the clutch is connected in parallel with the motor circuit. Both circuits may be cut off and on as desired, by adjusting the circuit controller. The motor drives the armature of the clutch through the train of gears. Unless the clutch coils are energized, the clutch and shaft will remain stationary, if current is supplied to the motor alone. But, if the motor current is taken through the clutch coil and brake coil at the same time, the shunt coil is also connected across the line and the clutch is energized, attracting the armature to it. The friction

between the faces in contact then causes the clutch to move, driving the shaft. The clutch is then used as a drum about which a chain is wrapped, giving the pulling power which operates the signal arm described above, through a wire connection. When the arm is in the position desired, the motor circuit is broken, while the shunt coil remains energized, holding the arm in that position. If the current be cut off from the shunt coil, the clutch releases the armature and the blade returns to the horizontal position as described above. The part which the magnetic brake plays is to prevent the gears from drifting backwards, on account of the weight of the spectacle casting, when the blade is held in the 45 degree or 90 degree position.

It will no doubt surprise the readers when they know that the tension on the connecting wire in actual operation is about 130 pounds, and that when clutch is energized, under operating conditions, it would take a weight of about 2000 pounds to separate the clutch and armature faces. It should be born in mind that the only force acting to drive the clutch and shaft is the friction between the armature and clutch faces, when the clutch coils are energized. This is the foremost feature of the entire mechanism. The following diagrams of circuits will make clear the exact wiring used in this installation as a three position mechanism.

Fig. 4, page 36, shows in diagramatic form what may be termed the internal circuit for the three position mechanism.

The battery, o, supplies the current at a pressure of 10 or 12 volts; the disk, f, carried on the clutch shaft, controls the current through the shunt coils of the clutch; while the disk, g, controls the motor circuit. The switches, p and q, show the manner in which the current must be delivered to the circuit controller. If switch, p, be closed, but q left open, the motor circuit is closed through contact brush, l; phosphor-bronze segment, r, of disk, g; contact brush, j; through brake coil, m; motor, n; contact brush, t; phosphor-bronze segment, c, on clutch; series coil, e, of clutch; phosphor-bronze common segment, b; to negative battery. At the same time, a parallel circuit is closed through contact brush, i; phosphor-bronze segment, s, of disk, f; contact brush, h; contact brush, v; segment, a; shunt coil of clutch, d; common segment, b; contact brush, u; to negative battery. The motor runs, driving the train of gears as explained above, and, as both clutch coils are energized, the clutch attracts the armature and is driven by it, moving the shaft, and consequently the circuit controller disks, f and g. The chain connection winds about the clutch, causing the drum, of same diameter, in the top bearing on the semaphore shaft to rotate with it, thus driving the spectacle casting and blade through the same angle that the clutch moves. This motion continues until shaft turns through 45 degrees,

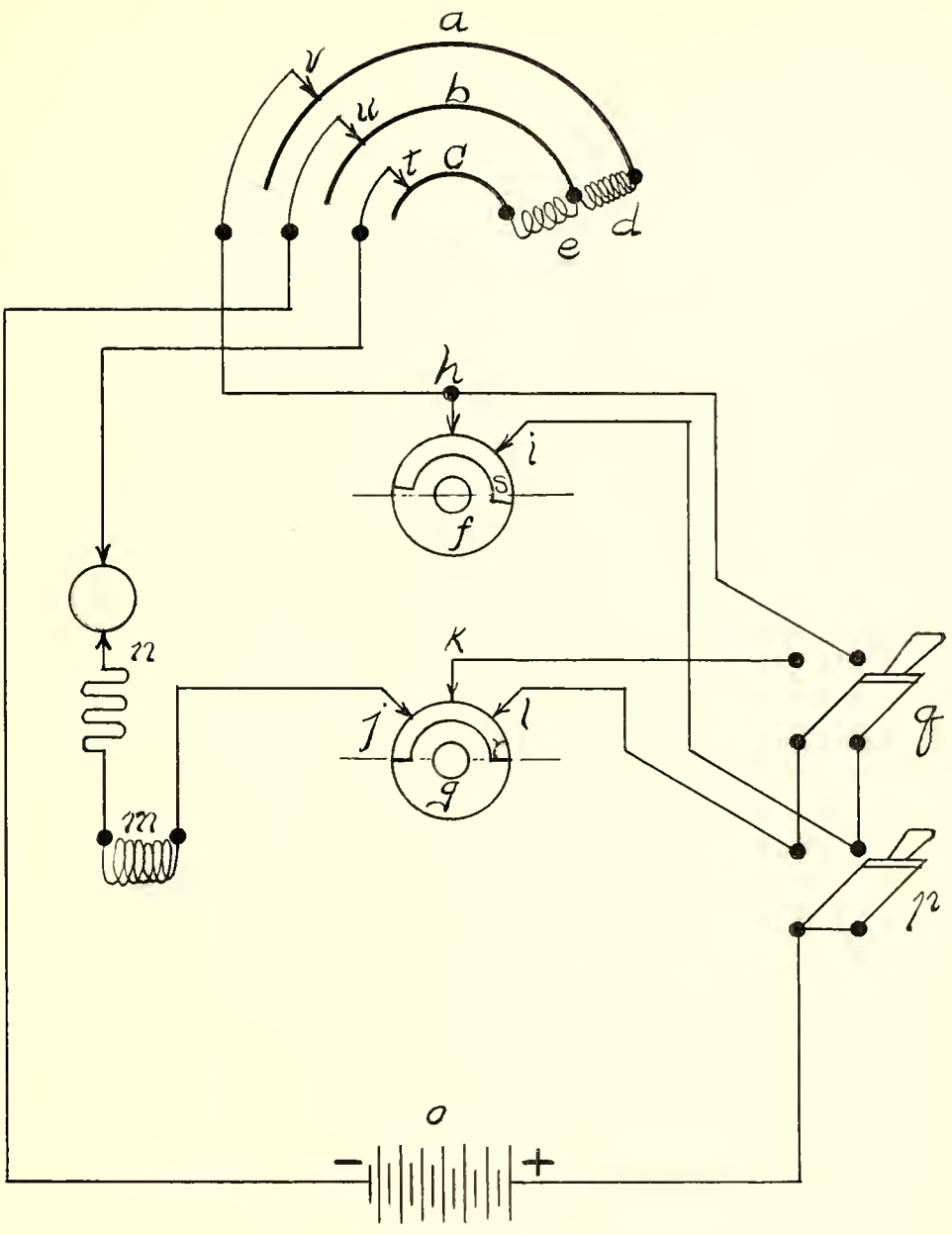

Fig. 4

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when contact is broken between brush, l, and segment, r, of disk, g. This cuts off the motor and the mechanism stops. Disk, f, is adjusted so that brush, i, and segment, s, break contact when shaft has moved 40 degrees, or 5 degrees behind the breaking point of brush, l, and segment, r, of disk, g. Thus the shunt coil remains energized and the clutch still holds to the armature with the blade at an angle of 45 degrees. Now, if switch, q, be closed, the motor circuit is again closed through brush, k, and segment, r, on disk, g, and the motor again drives the armature through the gears and carries the clutch around until contact is again broken between brush, k, and segment, r. Since brushes, k and l, are just 45 degrees apart, the clutch moves through 45 degrees and the blade is pulled down through a 45 degree angle, placing it in the vertical or 90 degree position when contact is broken at k. The shunt coil is energized at all times direct from the switch, q, thus holding the blade in the 90 degree position after the motor is cut out, as long as q and p remain closed. If q is opened, the shunt coil circuit will be broken, the clutch released, and the blade will return toward the horizontal position until it comes to the 45 degree position, when contact is again made at brush, l, on disk, g, and contact, i, on disk, f. The motor is at once cut in and operates until the blade is returned to the 45 degree position, the weight of the spectacle casting having caused the clutch to slip slightly past the 45 degree posi-

tion toward the horizontal. Thus, the slipping of the clutch acts as a cushion and there is no appreciable jar on the mechanism. If switch, p, be opened, it is evident that all current is cut off from the mechanism and the blade and spectacle casting return to the horizontal position as described above. If switches, p and q, are both closed at once, the mechanism completes the entire 90 degree stroke without stop. It is seen that all current for the 90 degree position must pass through the 45 degree position switch; i.e., switch, p, must be closed before the closing of switch, q, will have any effect on the mechanism. The reason for this will be seen when the circuit is applied to the track control.

The direct application to the track is shown in diagramatic form in Fig. 5, page 39. This will show the first step in the working out of the entire circuit plan of this installation.

Three signals have been represented in Fig. 5; i.e., one in each of the three positions. Signal on #1 is at "stop" or 'danger'; signal #2 is at 45 degrees or "caution" and signal #3 is at 90 degrees or "clear". The sections of track, A, B and C, between signals, are the "blocks". The condition represented by the three signals is that of a train in block C, pointed out in the specifications. The diagram has been lettered for clearness the same as the diagram of Fig. 4. It will be readily seen that the only change is that the hand throw switches, p and q, of Fig. 4,

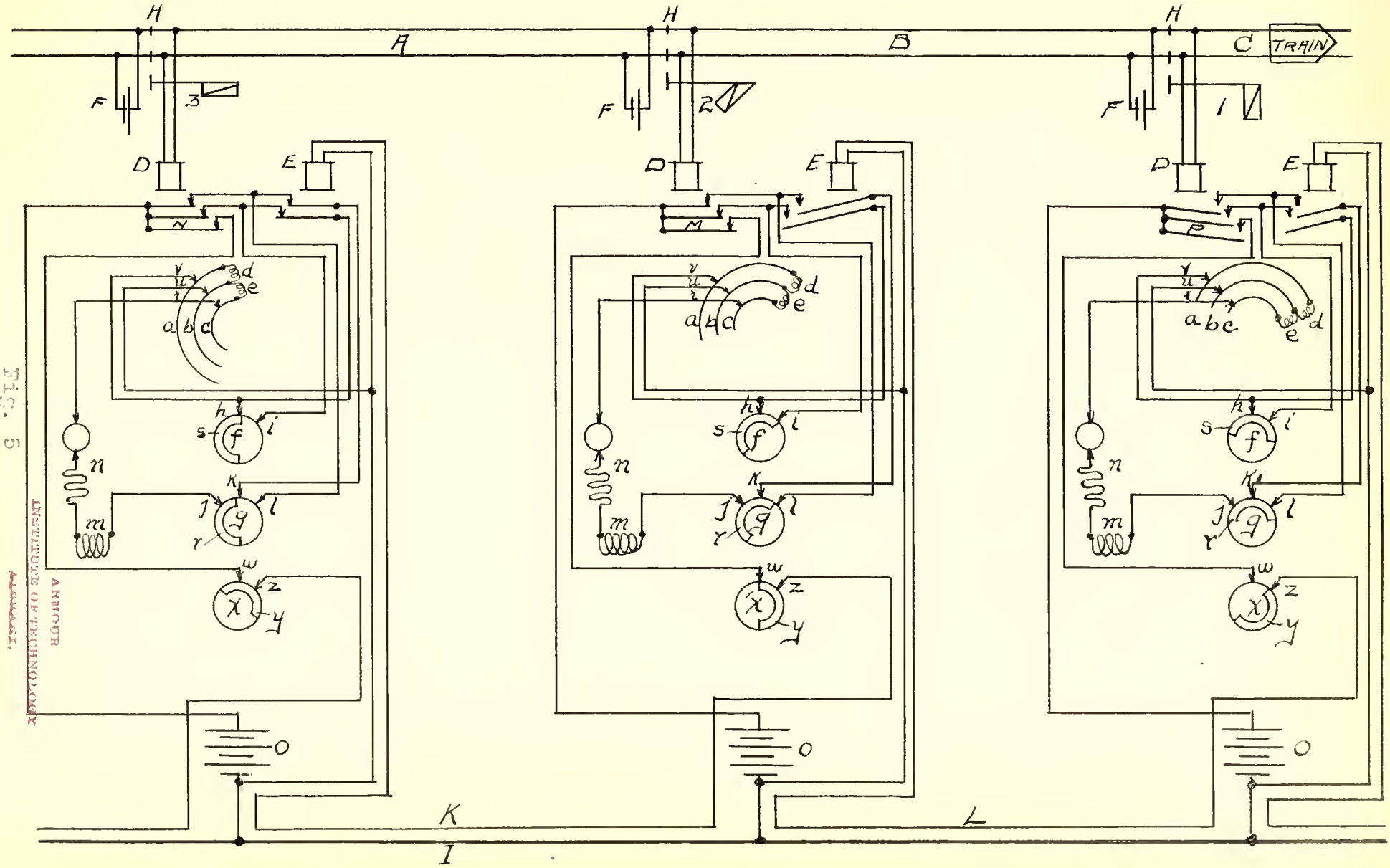

Fig. 5

have been replaced by the magnetic switches, D and E, which in the signal world are known as "relays". It is thought best that these relays be described at this time so that the circuits of Fig. 5 may be more easily understood.

The relay used is of the enclosed type, and is shown assembled in Fig. 8, page 41, and Fig. 9, page 42. The base, a; the top, b; and the coil tops, c, are moulded into shape from a special insulating compound. The glass cylinder, d, is clamped between a and b by two bolts which are sealed in place, making all joints watertight. The magnet cores, e, are of round Norway iron, 5/8" in diameter, turned from 1" square iron, so that the pole faces are 1" square. They are fixed to the moulded top by countersunk head screws put through from the top, and screwed into the core on the upper side of the pole face. The coils, f, are found wound on brass spools, with enameled wire, and are enclosed in a hard rubber casing. They are placed down over the cores, and are held in place by the iron yoke, g, which is clamped against the shoulders of the cores by the nuts, h. The moulded coil top, c, supports the binding posts, i, which are the terminals of the coils in series. The coils are connected together at the binding post, j, shown in Fig. 9 This same post, j, serves to bolt the two coils together so that they may be handled as one piece without breaking any connections.

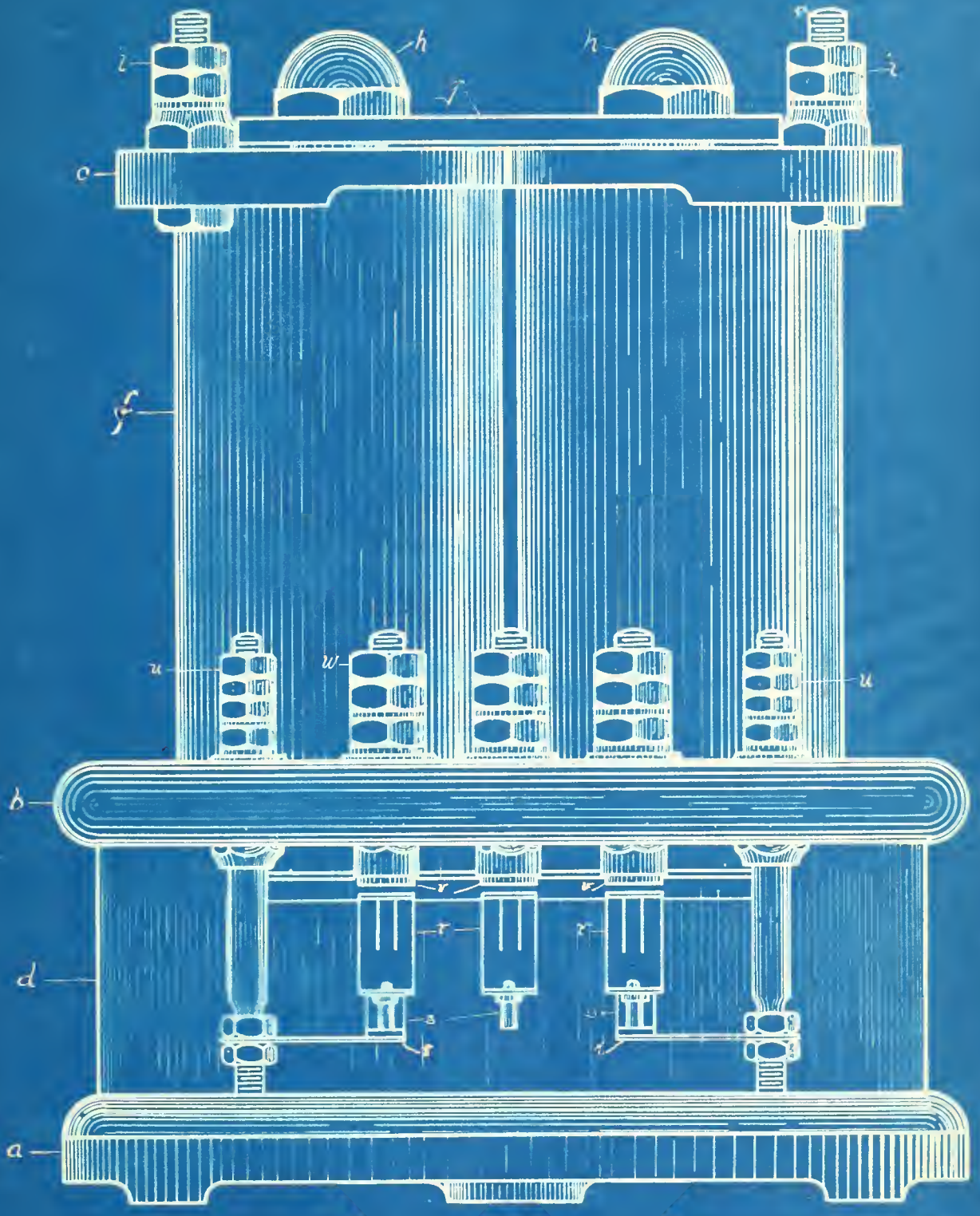

Fig. 8

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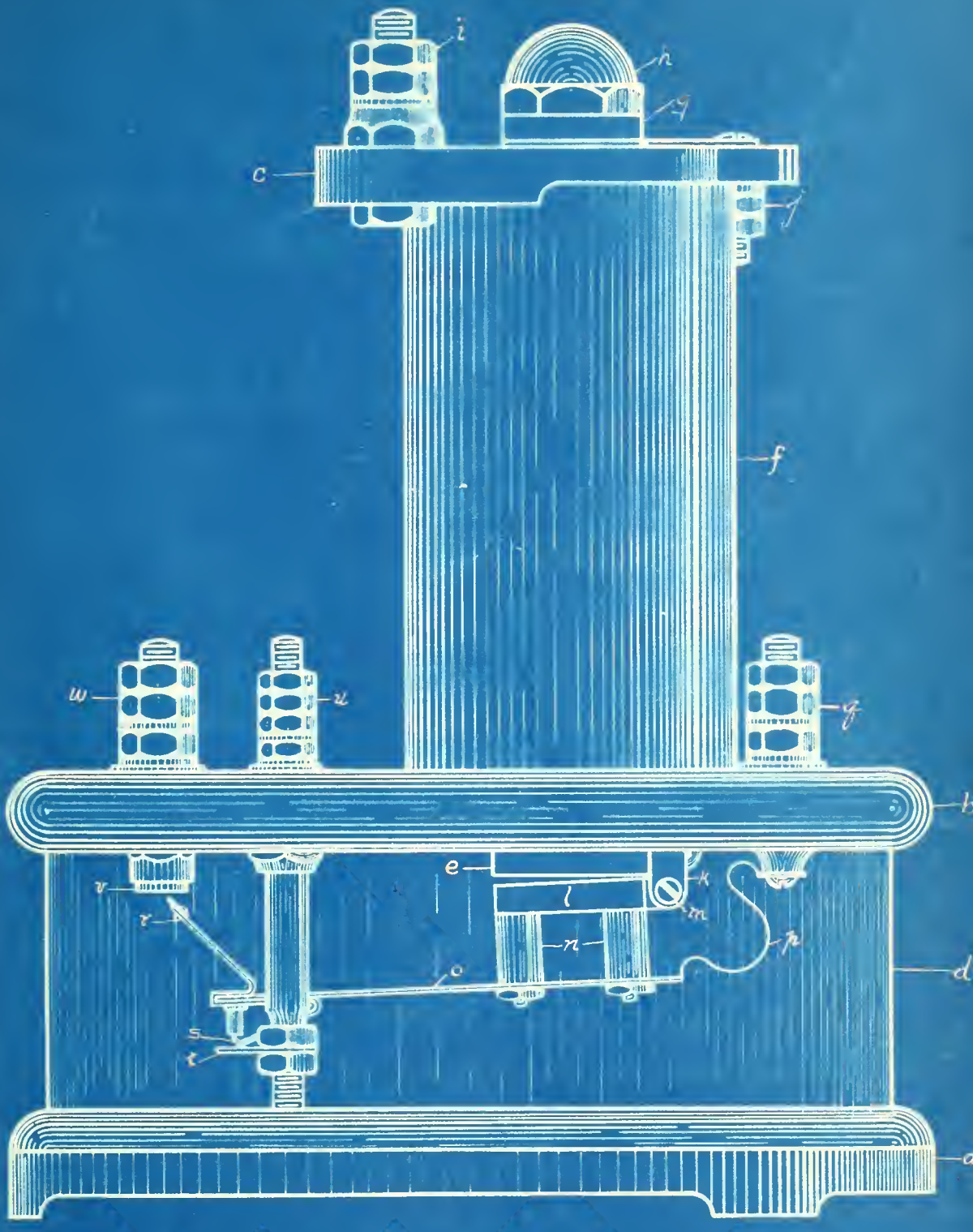

Fig 9

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To the pole cores is fastened the armature support, k. This is of brass and extends from one core to the other, having a single screw into both. The armature, l, is pivoted on the German silver screws, m, (one on each side). Projecting from its under side are the bone studs, n, supporting the copper connecting strips, o, the back ends of which are connected by flexible copper connections, p, commonly called 'spider wires', to the binding posts, q, clamped into the moulded top. The front ends of the connecting strips, o, carry the front spring contact points, r, which are tipped with platinum, also the back spring contacts, s. As the armature is down, the back spring contacts rest on the copper bars, t, which are held by the binding posts, u, which are also clamped to the moulded top. The front spring contacts are lifted up against carbon cylinders, v, held in place by the binding posts, w. Thus, with the armature down, a circuit is closed through binding post, q; spider wire, p; connecting strip, o; back spring, s; bar, t; and binding post, u. If the armature is attracted by the cores, the contact strips are lifted and the circuit is transferred from binding post, u, to binding post, w. The first is known as a "back point' contact; the latter, a "front point" contact. Thus, all relays used in this installation have three front points and two back points.

The features of this relay are its compactness and the ease with which the coils may be changed. Fig. 10,

page 45, shows the top with yoke and coils removed. It is to be noted that this constitutes what might be considered all working parts, and they are all fastened to one and the same top. There is no chance for any part to change its position and thus destroy adjustments. Fig. 11, page 46, shows the form, wound coils removed. The resistance of these coils varies as desired and it is evident how easily one may be replaced by another without disturbing any part or adjustment. The line relays used are of 1000 ohms resistance, while the track relays are of 4 ohms resistance. Each relay requires about 70 mil-amperes to pick up its armature with the weight of the points.

Returning again to the circuit diagram, Fig. 5, page 39, the relay, D, which replaces switch, p, of Fig. 4, is a 4 ohm track relay. The relay, E, which replaces switch, q, of Fig. 4, is a 1000 ohm line relay. As pointed out above, these relays are identical with the exception of the coil resistance. Relay, D, at signal 3, is operated by the battery, F, at signal 2, the circuit being made through the rails of section A. Sections A, B and C, are separated from each other by the insulating joints, H. Relay, E, at signal 3, is operated on the following circuit: starting at signal #2; positive side of battery O; front point, L, of relay, D; contact brush, w; phosphor-bronze segment, y; contact brush 2 of added disk, x, (disk x, and brushes, w and z, are the same as disks, f and g, described above.); by the line wire, K, to signal 3 through coil of relay, E, to line wire, I, and back to negative side of battery. C,

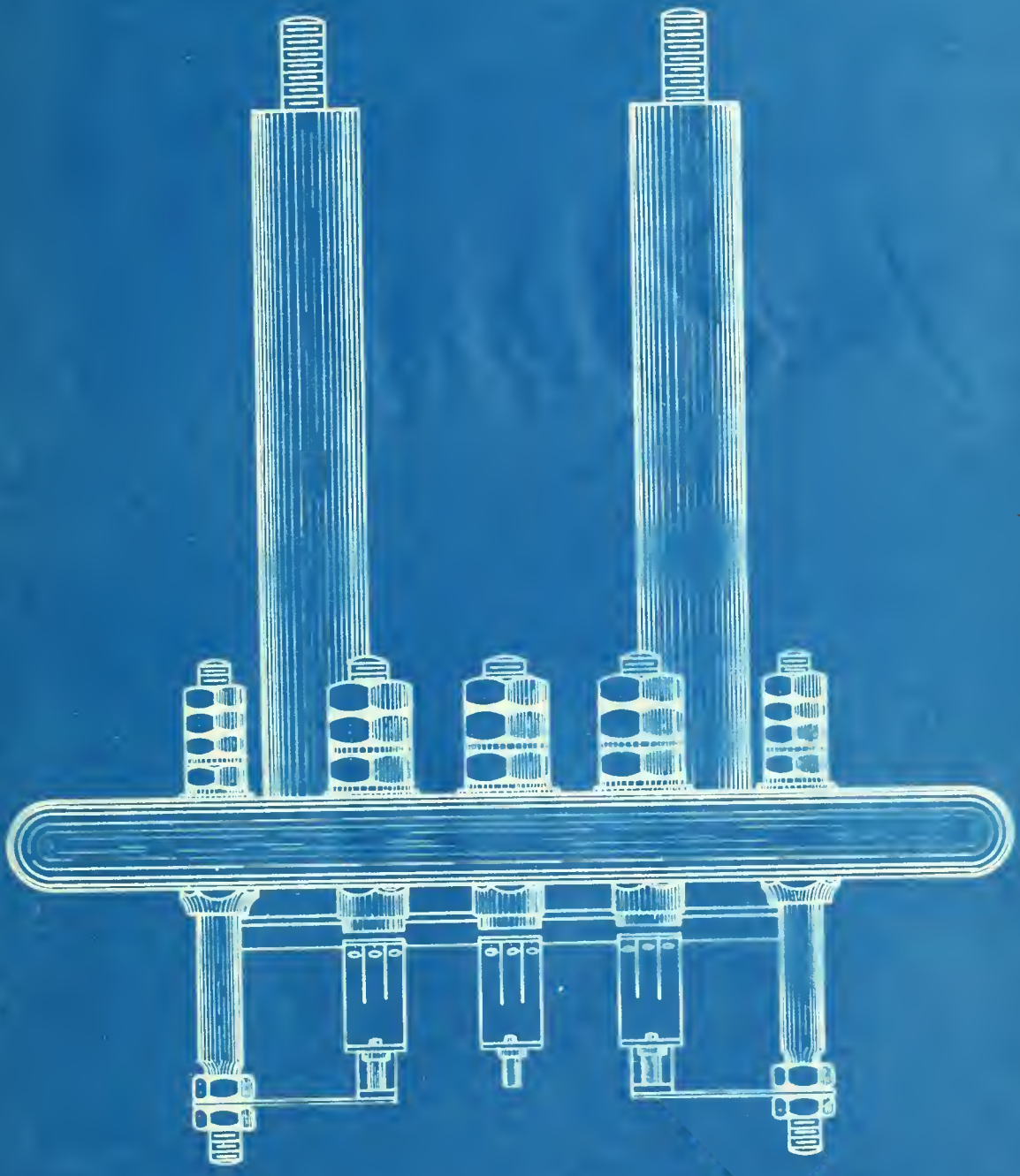

Fig. 10

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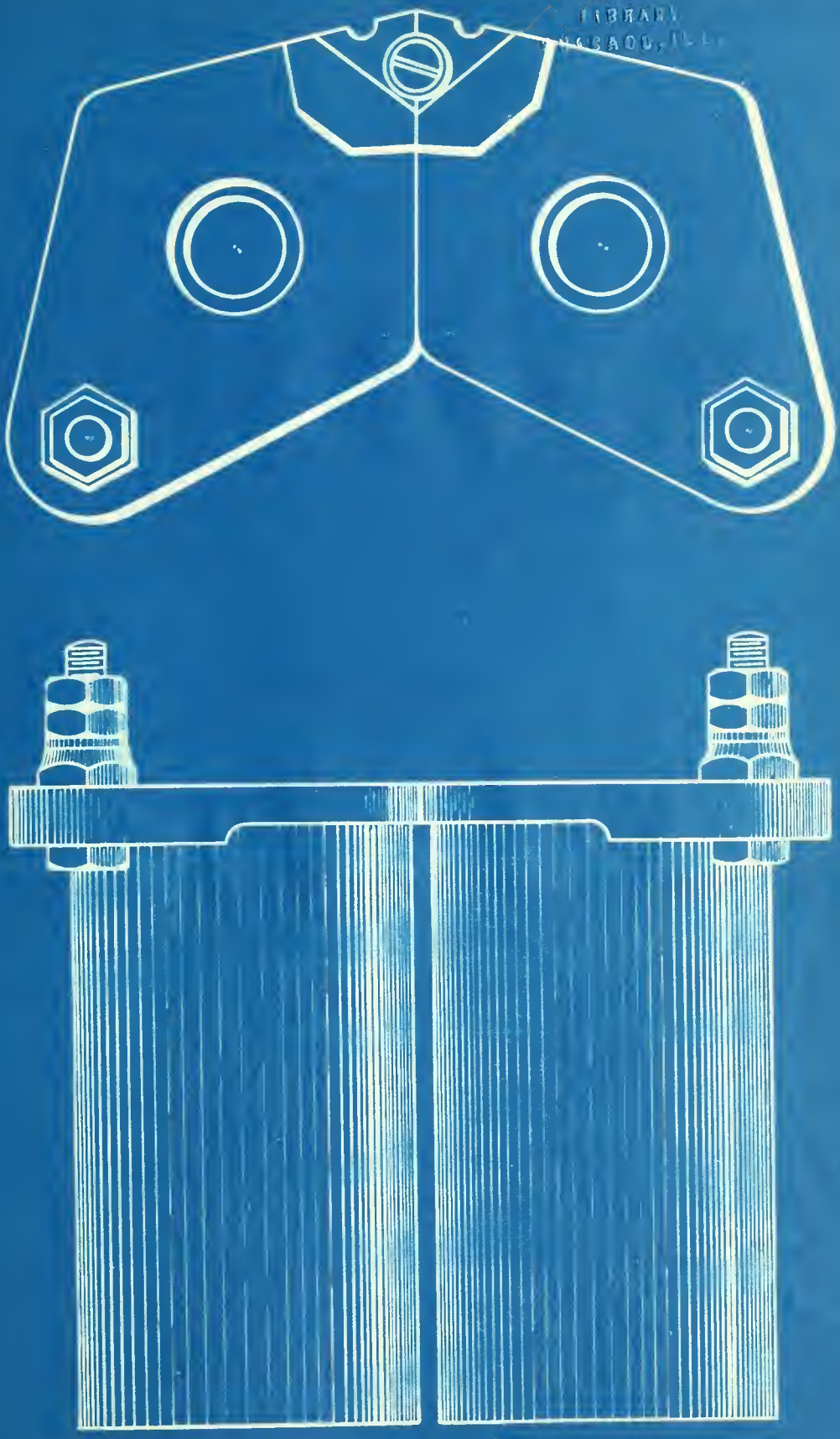

Fig. 11

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at signal 2. Disk, x, signals, 1, 2 and 3, is arranged to close the circuit from w to z when the signal blades reach the 45 degree position and it remains closed thereafter. It will be noted that disk, x, of signal 1 closes the circuit for relay, E, of signal 2 to the battery of signal 1. Thus, the relay, D, controlling the battery supply to the signal mechanism, and the 45 degree position is governed entirely by the conditions of the track section to which it is connected. Relay, E, controlling the 90 degree position for any signal is governed by the position of the signal directly ahead of it, which must reach at least the 45 degree position before current is admitted to its circuit. Thus, for any signal to display the "caution indication', 45 degree position, the current from track battery, F, must energize the coils of relay, D, attracting its armature and closing the front contacts as indicated; and further, for this signal to display the clear indication, 90 degree position, current from the next signal ahead must energize the coils of relay, D, attracting its armature and closing its front points as shown. It has been pointed out that the signal controlling relay, E, must be at caution or 45 degrees before current is admitted to it. Now, if a metallic connection of negligible resistance be connected from one rail to the other, of any section, it is evident that the battery, F, would be practically short-circuited. As a result, the coils of relay, D, would be disenergized and its armature would drop, breaking the front contacts and cutting off

all current controlled by them. In actual operation, the metallic connection from rail to rail is made by the axles of engines and cars; in this manner, they control the action of the signals.

Thus, as long as the track circuit of section, A, is not interrupted, the front points of relay, D, remain closed and signal, 3, would be held in the caution or 45 degree position; and, as long as the track circuit of section, B, is not interrupted, the front points of relay, D, signal 2, would remain closed and signal 2 would be held in the 45 degree or caution position; but signal 2 in 45 degree position closes the circuit of relay, E, of signal 1, which is pulled down and held in the 90 degree or clear position. Thus, for signal 3 to indicate caution, section or block A must be unobstructed. Therefore, for signal 3 to indicate clear, sections or blocks A and B must both be unobstructed.

With these conditions, the train in block, C, caused relay, D, signal 1, to open, breaking its front contacts, and signal 1 assumes the stop or danger position. In so doing, it breaks the circuit of relay, E, signal 2, and signal 2 assumes the caution position and signal 3 takes the clear position. In this manner, the indications specified are obtained.

In this installation, the battery, C, in each case, consists of six cells of 5 D storage battery connected in series, made by the Cloride Accumulator Company. These are of 40 ampere hour capacity, and one set is provided

for two signals when not more than 300 feet apart. Otherwise, one set is provided for one signal. The track battery, F, consists of three cells of ordinary gravity or blue vitriol battery connected in parallel.

In parallel with each set of storage battery is connected a set of 18 cells of gravity battery in series connection; that is, three cells of gravity battery are provided for each cell of storage battery. The gravity battery is used to charge the storage battery. While it does not have the current capacity to operate the signal mechanism, it can replace the energy taken out by the operation of a signal, at a low current rate, for the longer time between signal operations. The gravity battery will deliver a steady current until it is completely exhausted, when it must be renewed.

All storage battery, with its charging set of gravity battery, and all track battery, wherever possible, are kept in concrete battery wells or vaults, cylindrical in shape, being 5 feet diameter and 7 feet high inside measurements. An opening is provided in the top, about 24" square, which is covered by a galvanized iron cover, arranged to be locked in place. Three shelves are provided, which extend around the whole circumference of the well. They are cut in segments, with square radial ends, and are only supported on the under side. They are otherwise self-supporting, on account of their arch construction. Thus, the weight of the battery does not come on the nails and screws used.

The battery vaults are sunk in the ground until their tops are level with the top of the track rail. They weigh about 3000 pounds each and are provided with four hooks on an iron band about the bottom, for handling. They were lifted from the car and lowered into the hole prepared for them, by a wrecker crane.

In places where track battery can not be placed in battery wells, cast iron chutes are provided. These chutes are 7 feet long and about 12 inches in diameter. They are placed 6 feet in the ground, and the battery is raised and lowered by means of an elevator and rope. They are used in this installation at the street car line crossings and at the ends of the line where no battery vault is used. They are also used in connection with the relay boxes at the advance locking sections (these are explained later), where they not only shelter the track battery but also serve as a foundation for the relay box. This combination is shown in Fig. 12 and will serve to explain both battery chute and relay box.

Fig. 13, page 61, shows a sectional view taken through the center of the relay box, battery chute and elevator. The chute, a, is placed in the ground up to the shoulder, b. It is covered by the cast iron cover, c, a plan view of which is shown in Fig. 14. Within the chute at the shoulder, b, is placed the circular board, d, which makes a comparatively tight joint with the shoulder of the chute, and is called the frost board. Its purpose is to make that portion of the chute below the ground line

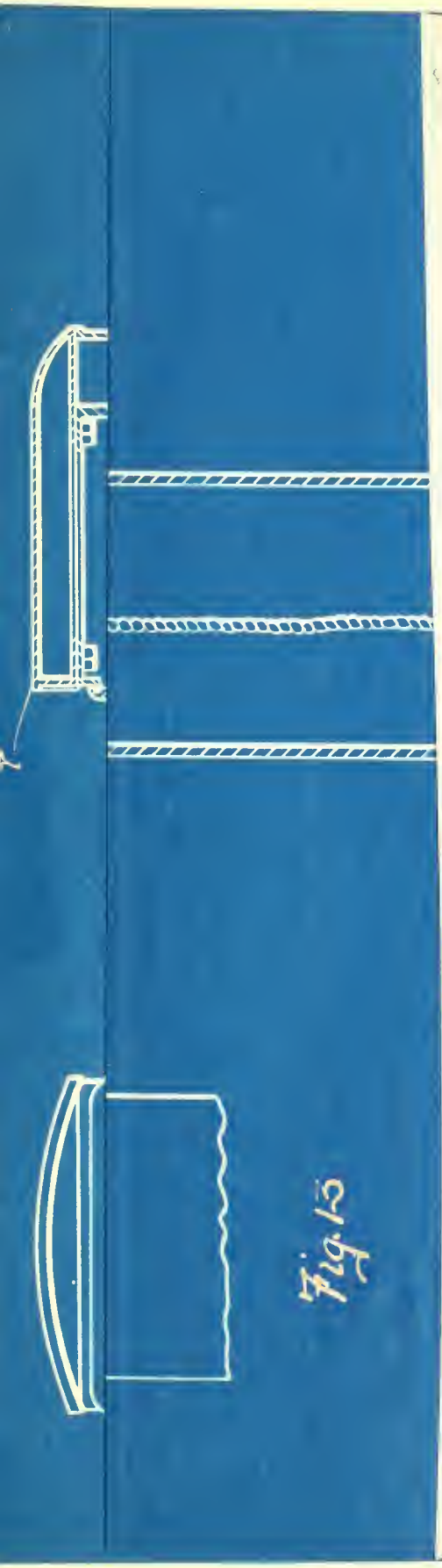

Fig. 13

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Fig 13

Fig. 14

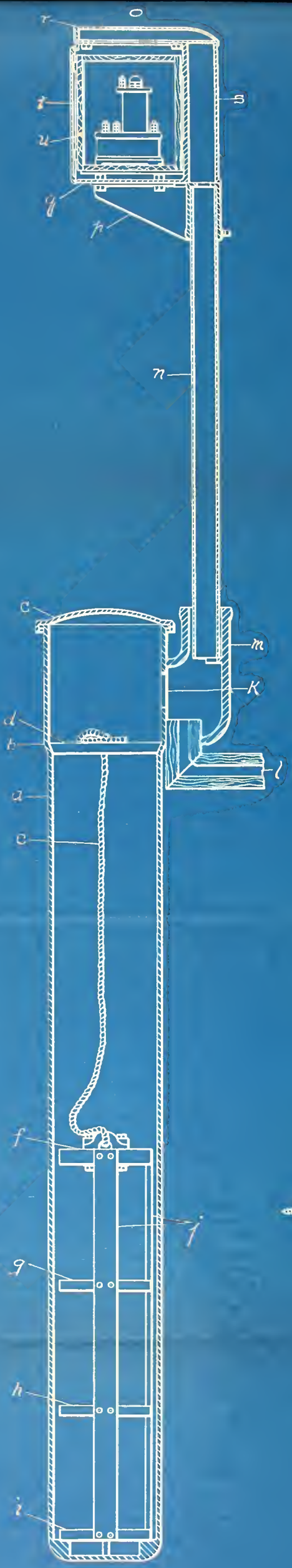

Fig 12

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as tight as possible so as to lessen the danger of the battery below freezing. The rope, e, is suspended through the frost board and attached to the top of the elevator, f. The elevator has three shelves, g, h and i, each of which supports one cell of the track battery. The shelves are held together by the three slats, j. The elevator, with its battery, may be drawn out of the chute by the rope, e. In the back of the top of the chute, an opening, k, is made, to admit the wire to be run to the battery. When the chute is used alone, these wires are led directly out through the trunking, l, and casting, m, is replaced by a plain closed top casting. Otherwise, casting m supports the post, n, of 2' wrought iron pipe, which supports the relay box. o, at its top.

The relay box, o, is made in sections. It consists of the base, p; middle section, q; top section, r; back section, s; and door, t. A wooden box, u, is placed inside of the cast iron box, and the door, t, is also provided with a wood lining on springs, which, when the door is closed, is pressed lightly against the wooden box and makes a dust proof casing. The back section, s, is trough shaped, being 2" inside diameter, and bolts directly to the back of the middle section, q. The reason for making back section removable is to facilitate running the wires into the box. These wires must pass up through the post, and run through small openings in the back of the middle section, through the wood lining, and to the relay.

The object in making the top, r, removable is that, by removing top, any number of the sections, q and s, with door, t, may be placed upon each other, and the top, r, placed on the whole, thus giving box capable of holding any number of relays desired. A front view of the relay box and the top of the battery chute is shown in Fig. 13.

Since the track circuit maintained for each block or section is the most important part of the installation, as it is through this that the control of the signal is with the train, great care must be taken to give the current its best path through the rails and relay coils. At each joint, the rails are connected or bonded together by two #8 BB Galvanized iron wires, 52' long. They are connected to the rails by drilling two 9/32 holes through the web of each as close to the end of the fish plates as possible, putting the end of a wire through each and plugging them with channel pins. The channel pin is of steel 1/4" in diameter at one end, 5/16" at the other, and 1" long. On one side a groove is cut, parallel to its axis, just large enough for the #8 wire to bury itself until it is within the circles of the 1/4 and 5/16 ends. The pin is inserted into the hole in the rail from the opposite side of that from which the wire is inserted. The wire is placed in the groove, and the pin is driven tightly into the rail. On account of its taper, it is pressed hard against the wire and the rail, thus making a good contact. Two wires are used at each joint to make the connection doubly sure, as

they are exposed and subject to rough use at the hands of track walkers and section men, in tightening and tamping joints.

The insulating joints used to separate one section from another are known as the "Rock" joints. Fig. 15, on the following page, shows an assembled joint, while Fig. 16 shows a sectional view. The track rails are shown at a and b. The ordinary fish plates and bolts are removed, and the plate, c, with the section of rail, d, riveted to it is placed under the rails, a and b. The wood block, e, and the fibre strip, f, are inserted between the rail, d, and the rails, a and b; while the fibre plate, g, is placed between the bottom of the rails, a and b, and the sole plate, c. Bolts, h, extend through rails, a and b, and rail, d, wood filler block, i, and the iron strap, j. These bolts are insulated from the rail, d, and strap, j, by the fibre bushings, k. Between the ends of rails, a and b, a fibre plate 1/4" thick, and cut in the shape of a section of a rail, is inserted to keep the ends apart. These are known as end posts. Thus, rail, a, is insulated from rail, b. The object of the reinforcing rail, d, is to carry the car wheels over the joint, thus preventing rail ends, a and b, from being worked up and down as the wheels pass from one to the other, protecting the fibre plates, f and g.

The switches in the track sections are insulated by cutting the rods which tie one side to the other. The ends are separated 1/2" from each other and two wrought iron

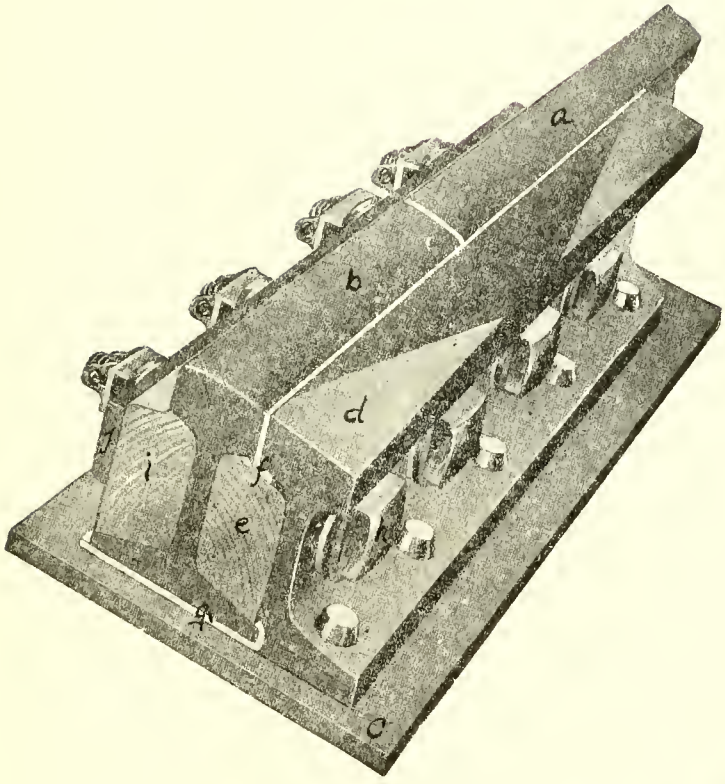

Fig. 15

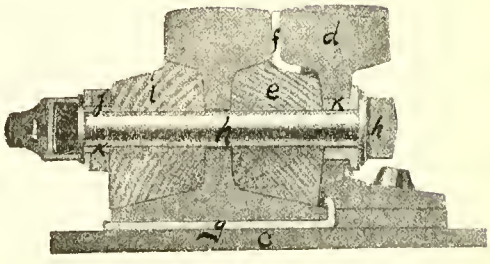

Fig. 16

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straps placed, one on each side. A fibre plate separates these from the switch rod. Holes are drilled through the straps, fibres and switch rods, and fibre bushings inserted in the holes through them. They are then bolted together and the insulation is complete. A length of two inches is cut out of the middle of the tie plate, on which the points move. These ends are drilled, and each fastened to the tie with the rail spikes.

In many places in this installation, switches and derails, which are located on curves and in interlocking plants in charge of other roads, are not insulated as described above, but are simply cut out of the track section by insulated joints. The former is done in order to preserve the solid tie plate from one rail to the other, on account of the great tendency for the rails to spread on curves. In the latter case, it is merely a question of maintenance. As the road controlling the interlocking plant has charge of the maintenance, their repairman will not give the attention to the insulation of the switches and derails that they should have; while, if insulated joints are used, the track department must keep these joints in good condition, and no trouble is experienced with the signals operating through such blocks.

All pipe lines controlling switches and derails on the tracks which affect the signals are insulated just as they leave the track, so that no track current may get into the pipe lines and find its way back to the opposite rail.

In the wiring, the specifications were, by permission of the railroad company, departed from to some extent. #9 B&S soft drawn copper wire with 5/64 wall of rubber insulation, one tape and one braid covering, was used for all track connections; #6 B&S soft drawn copper wire with same insulation was used for the main battery leads from battery well to mechanism; #14 B&S soft drawn copper wire, with same insulation, was used for connections to line wire; and #16 B&S flexible wire, with same insulation, was used for connections in signal cases and relay boxes, i.e., such connections as are subject to frequent handling. The line wire is all #10 B&S hard drawn weatherproof insulated copper wire, with the exception of the common wire, which is a #8 B&S hard drawn weatherproof insulated copper wire.

Ariel cable was used for crossing the street car tracks and Illinois Central Railroad at Burnside; crossing Rock Island; Nickel Plate and street railway at Pullman Junction; and from pole line to tower at 112th Street Calumet Drawbridge; Burnham and State Line. At all other railroad crossings and interlocking towers, wires were run.

The Ariel cable used was of four different sizes, in order to fulfill specifications calling for four extra conductors: one size, consisting of six #16 B&S and one #10 B&S copper wire; one consisting of nine #16 B&S and one #10 B&S copper wire; one consisting of eleven #16 B&S and one #10 B&S copper wire; and the fourth consisting of fourteen #16 B&S and one #10 B&S copper wire. At the

terminals of the cable, standard Western Union cable forms were used, and the lightning arresters for protecting the cable placed in them.

The lightning arresters used are of the choke coil type. The coil is wound around glass tubing which is filled with iron wire and is supported at each end by a small brass casting, both of which are fastened to a slate base 1 inch wide and 5 inches long. The ground plate runs under the coil and is separated from it by a thin piece of perforated mica. At the ends the ground plate is notched and the points placed close to the brass terminals. These brass terminals also serve as binding posts. They also support an insulating strip carrying a third binding post. A fuse of two ampere capacity is connected from the middle post to either end. The line wire is connected to the remaining end, and the circuit goes from the line through the choke coil, then the fuse, and to whatever connection desired. A #9 B.&S. insulated wire is used for a ground wire. It is connected to all the ground plates of the arresters, is led out and plugged and soldered to the top of a one inch galvanized iron pipe which is driven into the ground to the depth of ten feet. This is a sufficient depth for all places, as the ground is very low, and wet quicksand may be reached at from two to four feet under the surface. In order to protect the main tracks from cars standing on side tracks, the rails of all switches are connected in parallel with the rails of the main track, as far back as

the clearance or fouling point. Insulated joints are inserted at that point, and it is necessary that cars be placed behind these joints in order that the signal governing the immediate block may not be interfered with. To the point of the switch, which is closed when the switch is set for the main track, is attached a circuit controller commonly known as a 'switch box.' This is so arranged that when the switch point moves a distance of 1/8", it breaks the track circuit, and at the same time connects one rail with the other, thus shunting the coils of the relay as well as cutting the battery circuit. A diagramatic sketch of this arrangement is shown in Fig. 17, page 60.

The track section, A, is limited by the insulated joints, c, at one end and the insulated joints, d, at the other end. The battery, b, supplies the four ohm track relay, a. At the switch, C, the insulated joint, e, is installed in the main track rail, 1, and the joint, f, in the side track rail, h, as close to the switch point as clearance will permit. Just back of the point where the sidetrack becomes parallel with the main track, the insulated joints, g, are placed. These joints mark the fouling point of the switch. The wire, j, connects rail, h, with rail, 1. The rods of this switch are not insulated, as pointed out above in discussing interlocking switches; but the insulation is accomplished by the use of a wedge, m, which is so placed on the tie that when the switch is set in the normal position, the open point, q, is lifted

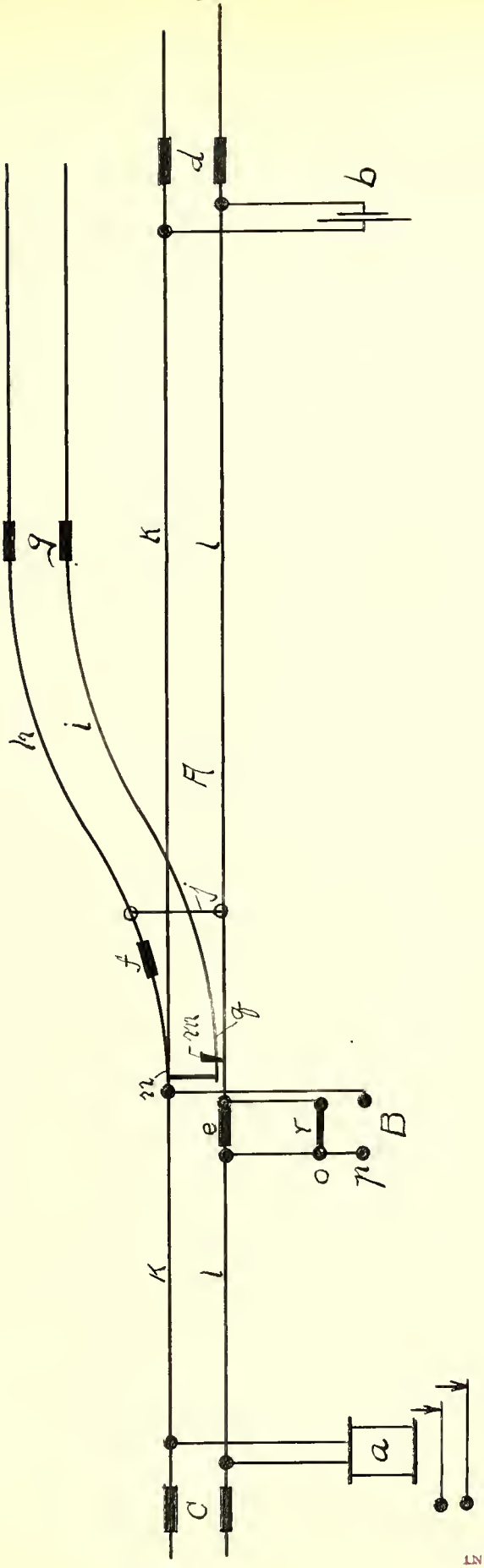

Fig. 17

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up so that it does not touch the rail, l, at any point. The tie plate is cut in the same manner as in interlocking switches.

The contact points of the switch box, B, are shown at o and p. It is noted that the contact bar, r, makes a circuit around the insulated joint, e, in rail, l; while the open contact, p, has one side connected to each rail. If r be moved from o, it breaks the track circuit which would cut all current from the coils of relay, a. At the same time, if r is moved so as to close the contact, p, it is evident that this would shunt the coils of relay, a. This gives double protection, as either would accomplish the result desired and both would have to be out of order to fail completely. The movement of r is controlled directly by the closed point, n, and it is only necessary that n be moved 1/8' to accomplish the full movement of r, with the above result.

The switch box, B, is shown in Fig. 13. The plan view shows a row of four controlling disks, the maximum number for which it is designed. These disks, a, and contact brushes, b, are the same as used on the circuit controller of the signal mechanism, and, therefore, these parts are interchangeable. The disks, a, are fixed to the shaft, c, which operates in babbitted bearings, d, and e. The contact brushes, b, are supported by the cap screws, f, which are threaded into the side of the case. Wires are brought into the box through the openings, g, under the binding posts of the contact brushes.

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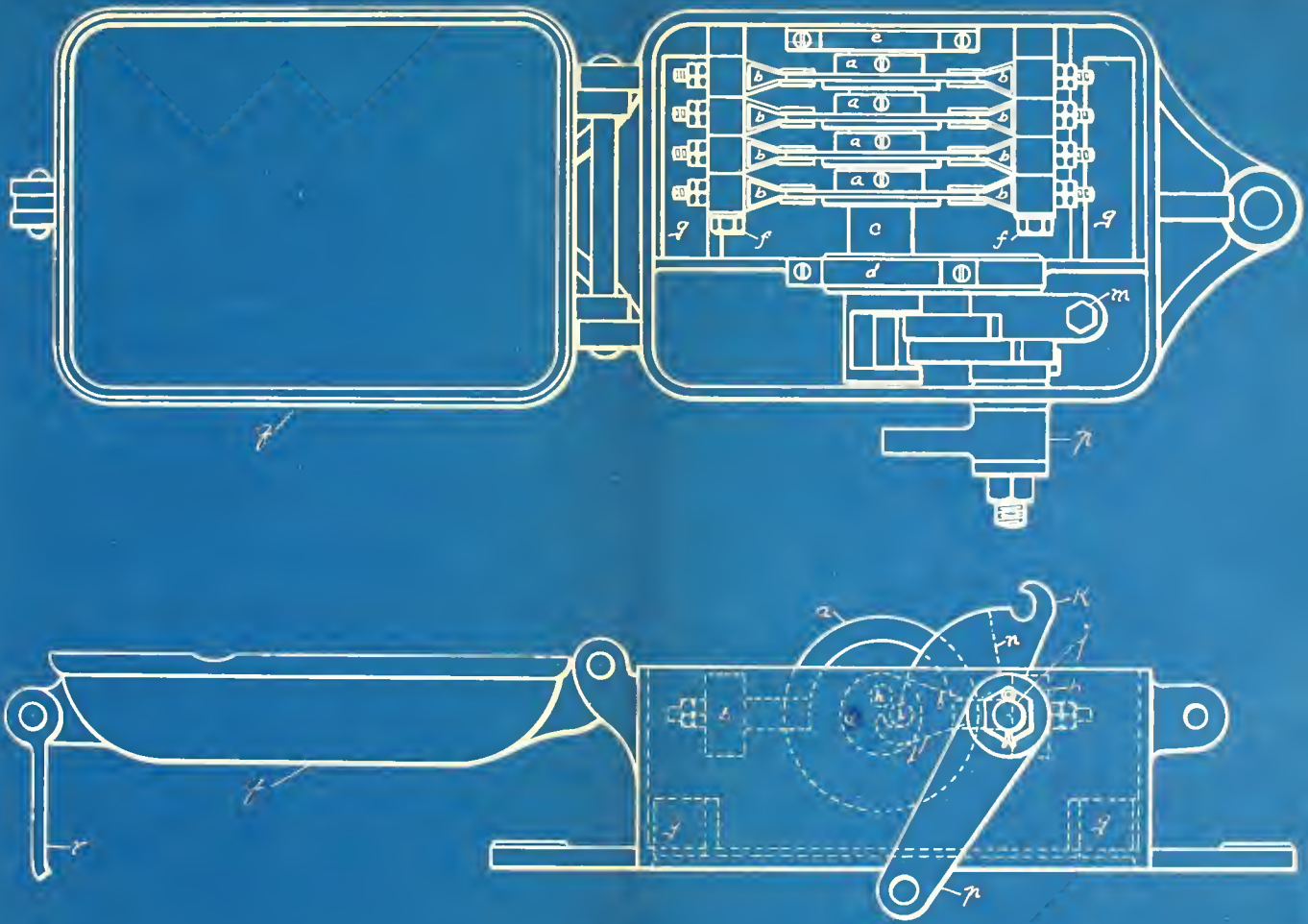

Fig. 10

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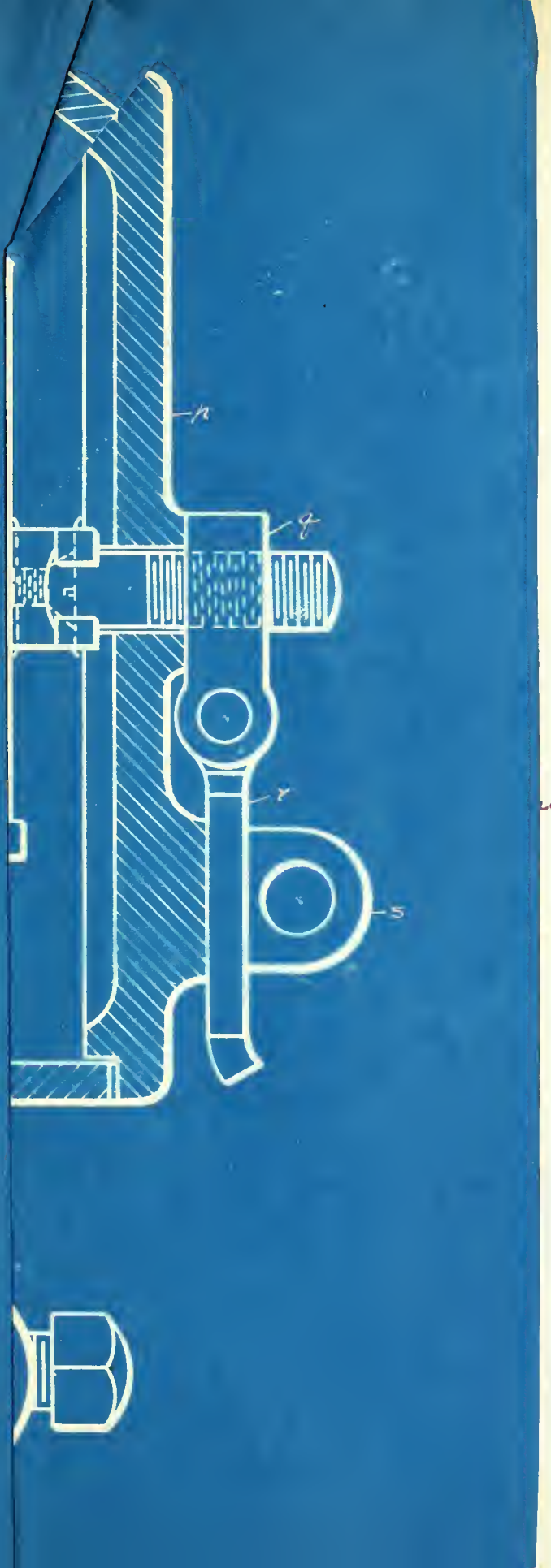
The outer end of the shaft, c, is slotted out to make room for the steel rollers, h, and i, which turn on screws fixed into the shaft. The crank shaft, j, carries the cams, k and l. These are two castings from the same pattern, turned back to back, so that their plain sides are together. Their hubs are split, and they are clamped to the shaft by bolts, m. They may be adjusted, therefore, to any position desired, to the limit at which lines, n and o, coincide, which is the maximum throw permitted. Crank, p, fits upon a taper squared portion of shaft, j, and is held in place by a nut and cotter pin. To operate the controller, consider crank, p, moved to the right. The shoulder of cam, l, engages the roller, i, and moves it downward, causing shaft, c, to rotate, carrying the disks with it. This rotation continues only until roller, i, allows cam, l, to pass it. In this position, both sides, h and i, bear on the circular surface of cams, k and l, thus locking shaft, c, in this position, as cams, k and l, continue to move as crank, p, moves. At the end of the stroke, the projecting portion of cam, k, strikes roller, h, driving it downward and rotating shaft, c, in the same direction. The action is the same on the reverse move. As pointed out in the circuit diagram of Fig. 17, all the contacts are moved by the first motion of the switch, so that it is only necessary to adjust cam, l, as shown, and place cam, k, at its extreme position so that it will not engage roller, h, at the end of the stroke, but will leave both rollers locking the position of the shaft, c.

Contacts are made as in the signal mechanism, i.e. a brush on one side through the disk segment to a brush on the other side. The disks may be adjusted as desired, to get the requirements pointed out in Fig. 17. The connection to the switch point is made by a rod from the lower end of the crank, p, directly to a lug on the switch point. The box is provided with the lid, q, which when closed makes a watertight joint on a felt gasket. It is locked by means of the hasp, r. The box is bolted to the switch tie, about three feet from the rail.

At each of the outlying switches, five in number, is located a switch indicator. This indicator is of the semaphore type and is a miniature signal enclosed in an iron case and operated electrically. They are placed on an iron pipe held by a cast iron base bolted to a concrete foundation. The foundation is also a miniature signal foundation, being 8 inches square at the top, 18 inches deep and 11 inches square at the bottom, with four 3/4 inch hook bolts built into it.

The purpose of an indicator at the switch is to show to the person about to open it whether a train is approaching so near that the switch should not be opened, or whether the switch could be opened without interfering with the movement of trains. The construction of the indicator is shown by a sectional view in Fig. 19 and its assembly by Fig. 20, page 65.


h
g
r
5

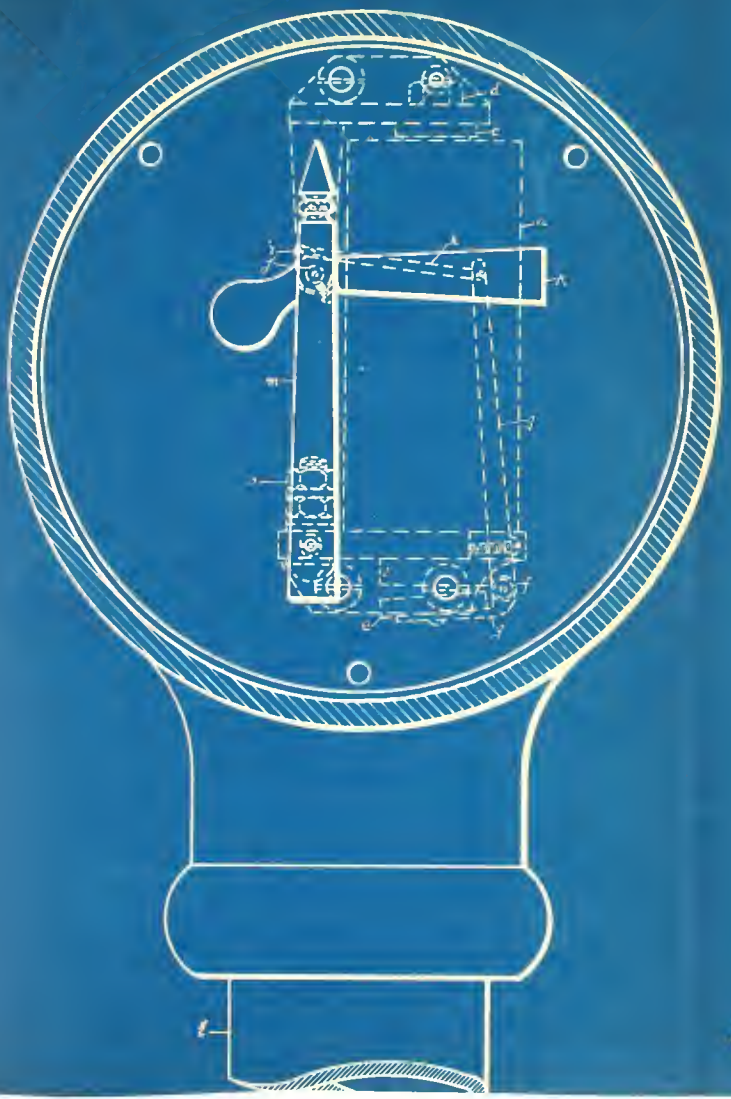
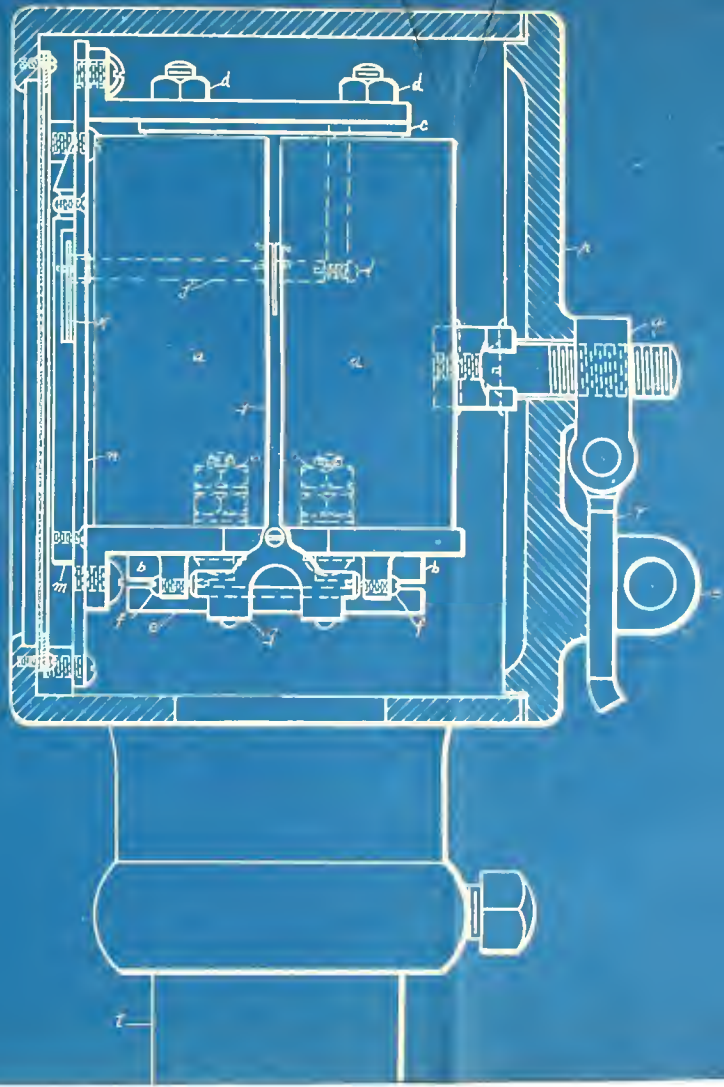


Fig 13



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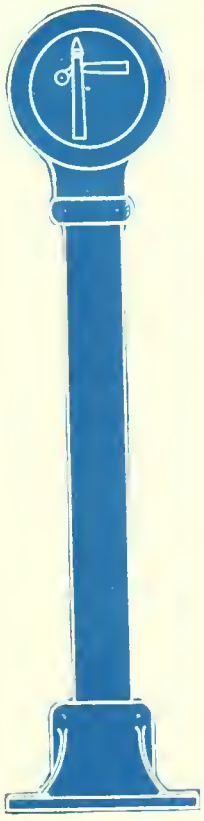

Fig. 2[illegible]

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The indicator consists simply of an electro-magnet with coils, a, of 1000 ohms resistance, with cores of 5/8" round iron whose pole faces, b, are one inch square. The yoke, c, is clamped to the cores by the nuts, d. The armature, e, is supported by the brass arm, f, which is pivoted at its back on the terminal screws, f. The long arm of g, projecting upward, carries the link connection, h, attached to the crank, i, which is fixed to shaft, j. This shaft carries the small metal blade, k, and is supported at one end by the trunnion screw, l, and on the other by the miniature pole, m. When the armature, e, is attracted to the pole faces by energizing coils, a, arm, g, is moved away from the coils pulling link, h, which by means of crank, i, causes the semaphore shaft, j, to rotate and with it the blade, k. When armature is at the end of its stroke, the blade, k, points downward at 60 degrees, which is the clear or safety indication, while the position shown is the danger position.

The danger position of the indication is obtained by the action of gravity, as in the main signals. The magnet is supported by the circular disk, n, which covers the whole front of the case and is enameled white. The binding posts, o, are the terminals of the coils to which the operating circuit is connected.

The front of the case is of glass, and the cover, p, is fitted into the back and pressed tightly against it upon a leather gasket, by screwing nut, q, which has the

has, r, attached to it. The has, is locked in position by placing a padlock in lug, s. The wires are brought up through the pipe post, t, and attached to the binding posts, o. The circuits for the operation of the indicators will be pointed out later.

All wires, with the exception of the line wires, are protected by placing them in grooved lumber or trunking. Three sizes are used in order to fulfill specifications for space. The smallest is made by cutting a groove one inch deep and one inch wide in a two by four. The second size has a groove one inch deep and two inches wide, and the third size is made by cutting a groove one and one-half inches deep by two inches wide in 3" x 5" white pine. Each size is covered by capping one inch thick and of a width equal to the width of the trunking.

All lumber is placed on 5' x 4" oak stakes, four feet long, driven into the ground. The trunking is all painted before being installed, with asphaltum paint. For wires crossing under tracks, the trunking is placed so that the top of the capping is at least one inch below the base of the rail.

All wires in signal cases, relay boxes, indicator cases, etc., are tagged with a black fibre tag, 5/8" wide and 1-1/4" long. On this tag is stamped the operation resulting from sending current through the wire to which it is attached. In addition to this, the number of the line wire to which it connects is stamped on the tag.

The line wires are tagged by nailing a circular numbered tag to the cross arm at the pin to which the line wire is tied. These numbers correspond to those on the fibre tags in the cases.

The semaphore blades are made of iron. They are 4' 5" long; 7" wide at casting end and 1½" wide at the outer end. They are bolted to the spectacle casting by six 3/8" carriage bolts. To keep them from warping, a strip of metallic door mail is screwed across the back, ten inches from the wide end. The front of the blade is painted yellow with a black stripe 3-3/4" wide painted across it fifteen inches from the outer end. The back is painted black, with a similar white stripe in the same position.

The lamps used are the #8 Dressel Semaphore lamp. They use kerosene and are arranged with burners and fonts to give eight day continuous burning without care.

At Calumet Draw Bridge, the line wire taken across the river through a lead covered submarine cable laid on the bottom of the river. The track circuits are carried directly across the bridge. To do this, a special circuit controller is necessary, which will make connections from the rails on the draw span to the rails on the abutment. The difficulties met in the design of such an instrument are chiefly brought about on account of the general motion of the draw span while a train is passing over it. Motion in all directions must be allowed. To

hood from injuring the contact parts and their protective covering. Fig. 21, page 70, shows the bridge circuit controller assembled, and a brief explanation will suffice to make its operation clearly understood.

The case, a, Fig. 21, is fastened to the abutment timber. The guide, b, is fastened to the end tie on the draw span. The case, c, slides back and forth on guide, b; its movement toward the abuttment case, a, being limited by the stop rib, d, striking the edge of the guide, b. The guides within case, c, the frame, e, slides. To this frame, the contact bars, f, of phosphor-bronze are connected by rivets, g. These contact bars, f, are guided at the end of case, c, where they slide through the hard wood block, h. Frame, e, is connected by rod, i, to the pipe line running out from a lever in the interlocking tower. Case, a, contains the cast brass contacts, j, which are pivoted at k and pressed together by the compression spring, l. The case, b, contains the phosphor-bronze contact brushes, m. Thus k is one end of the circuit and m is the other, the connection from one to the other being made through contact bar, f. If it is desired to disconnect the bridge from the abuttment, the lever in the tower is reversed, drawing frame, e, toward the rear end of case, c, and withdrawing contact bars, f, from contacts, j, thus breaking all circuits. At this point, the frame, e, strikes the rear end of case, c, and three inches of stroke still remain. Thus case, c, is moved away from

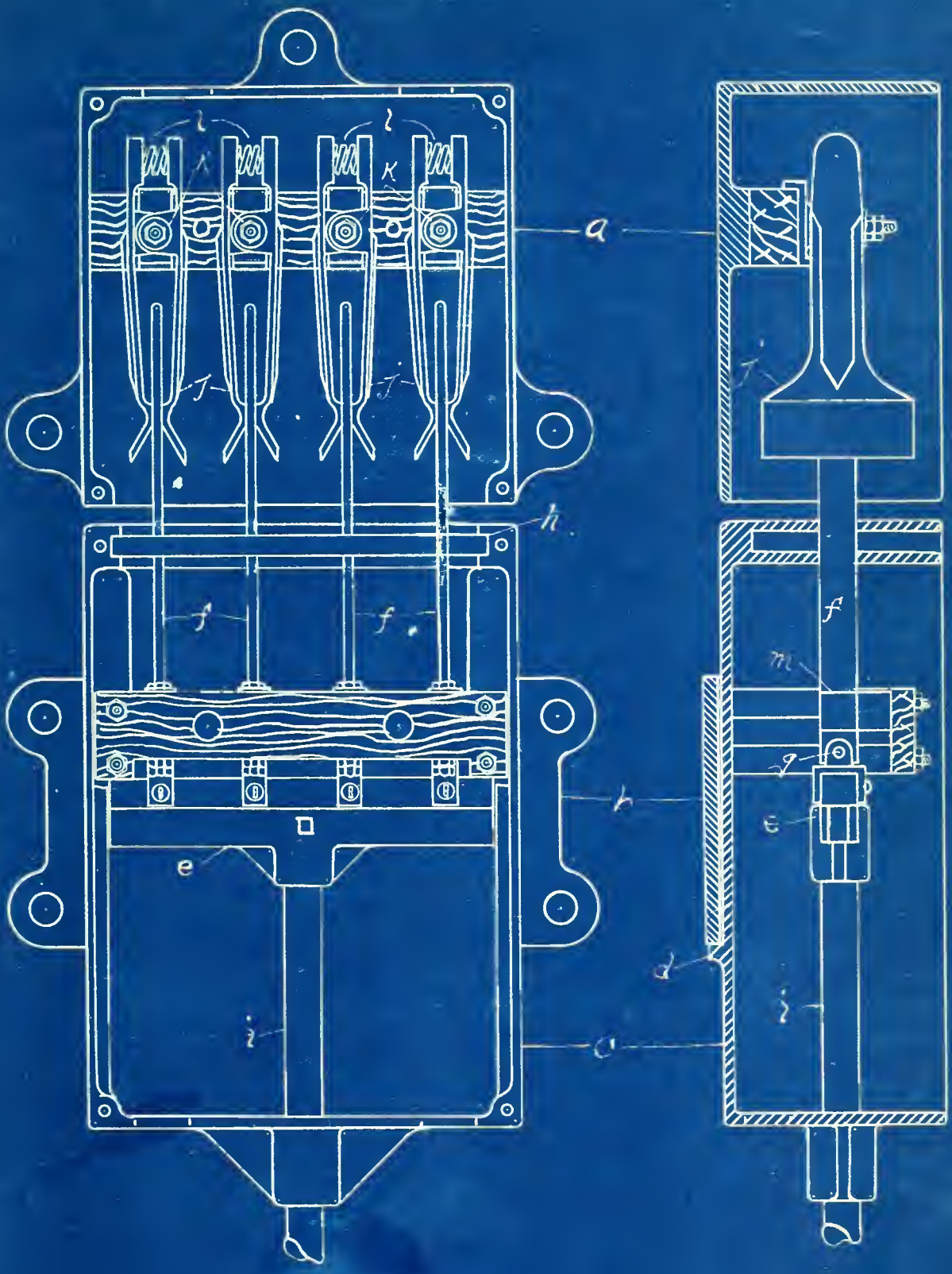

Fig. 21

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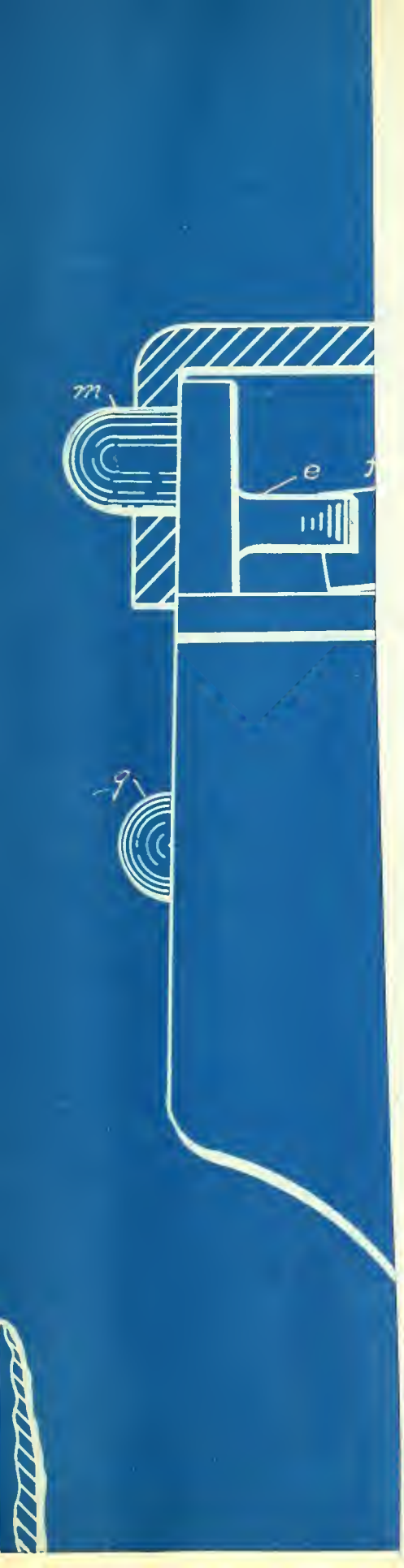
case, a distance of three inches, which gives plenty of clearance for the bridge to turn. The reverse movement is evident. One of these controllers is used on each end of the draw span, there being a double track across the bridge; i.e., four rails; consequently, the four contacts.

For the protection of trains at interlocking plants, every precaution has been taken. Electric locks have been applied to the mechanical locking of the machine, which not only prevents the towerman from moving switches when a train is nearing his tower, after he has once given it a clear signal, but also indicates to him that his signals are in their proper position by releasing the lock. Other indicators are used in the tower, which show to the towerman the condition of the track section through the interlocking plant. They also compel the towerman to return his lever to its normal position behind a passing train before he can again clear the same signal by reversing the lever. Screw releases, operated by hand, are also provided to release the electric locks, in case it becomes necessary to change a route with a train standing ahead of the signal. These require from ten seconds to a minute to operate, and the main purpose is to force the towerman to think of what he is doing before he could in any way endanger an approaching train.

The electric lock used in this installation is shown in section in Fig. 23, page 75. This is not only a lock but a circuit controller as well. The lock arm is attached to the armature of an electro-magnet similar to the switch indicator magnet, previouslt described. The coils, a, are supported by the magnet frame, b, which also acts as a pivot support for the lock arm, c. The short end of lever, c, is connected to the armature, d. The long end of the arm, c, extends to the end of the case, where it is guided by lugs, e, one on either side. Under these lugs, a circular cast iron disk, f, rotates on the shaft, g. This disk is notched out so that at a given point in its rotation the arm, c, will drop into this notch and lock the disk in that position. It is unlocked by energizing the coils, a, whose cores attract the armature, d, lifting the long end of arm, c, upward out of the slot in disk, f, releasing it. On disk shaft, g, hard rubber sleeve h, carries around its circumference contact strips of phosphor-bronze. These strips are of the same width as the contact brushes, i, and are entirely hidden by these in the figure. There are two rows of the brushes, i, the other row occupying a similar position behind sleeve, h, so that the circuits are controlled between a brush on the front side and a brush directly behind it on the back side; the contact strip in the circumference of h closing or breaking this circuit, as h is rotated with disk, f.


m
e
f
g

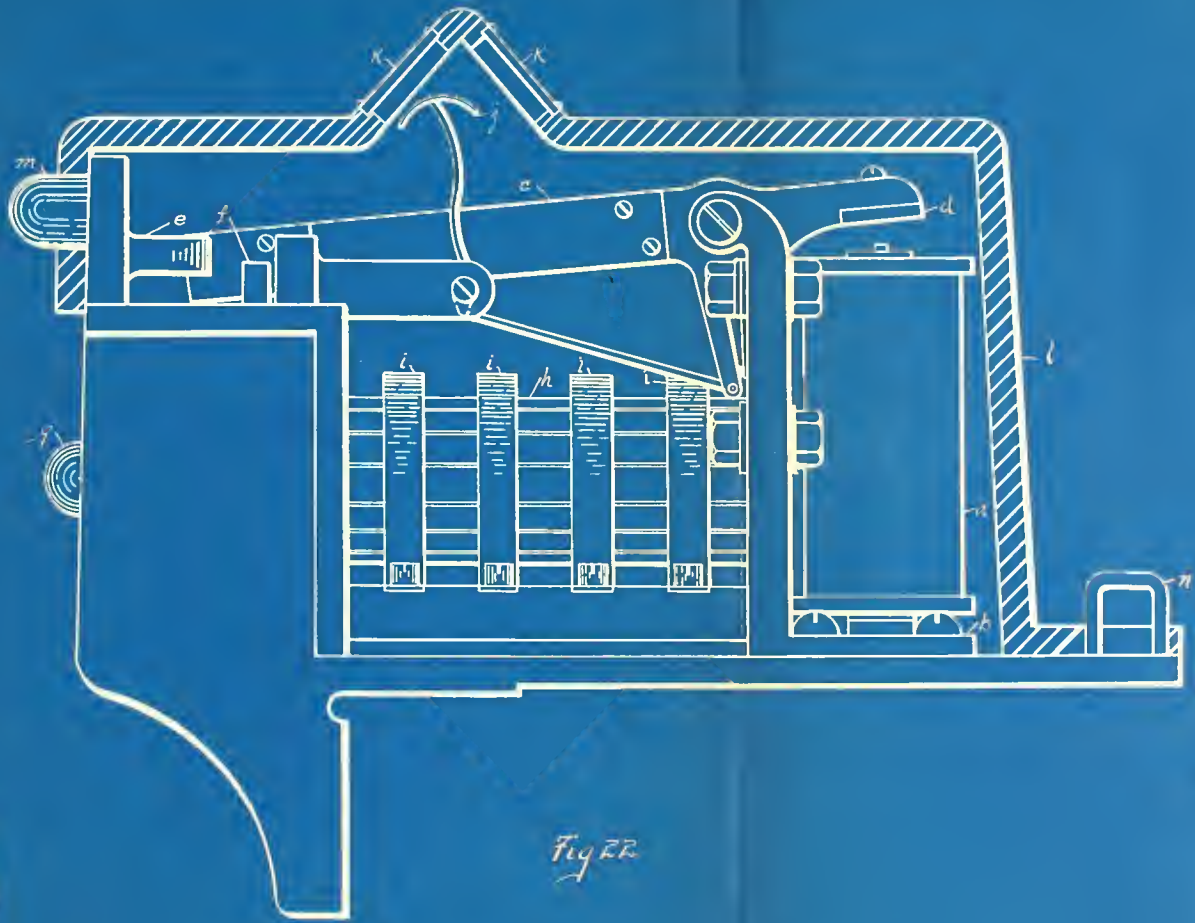


Fig 22

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The indicator, j, shows through glass covered openings, k, and is operated by the arm of the lock, thus indicating the position of the lock arm. The cover, l, is placed down over the lock and secured by first passing it over stud, m, then locking by means of a padlock in hasp, n.

The disk, f, through which the locking is accomplished, is driven through an opening directly under it, by connection with the latch of the interlocking lever. The notch in it may be cut in any position desired. It may be arranged so as to lock when the lever is normal with latch lifted; with lever reversed, latch down; with lever normal and latch down. In this installation, all notches are cut so as to lock the latch up, with lever normal. Fig. 23, page 75, is a mounted catalogue plate of the lock and its details, numbered for ordering.

There are three different types of interlocking machines in the eight interlocking plants embraced in this layout, i.e., six Saxby & Farmer machines, one National machine and one Standard machine. The manner of attaching the lock to the National and Standard machines is similar, but very different from that of attaching to the Saxby & Farmer machine. The attachment to the National machine is shown in Fig. 24, page 76, and to a Saxby & Farmer machine in Fig. 25, page 77. In the former, pin #5, to which the link driving the lock disk through #1, #2 and #3, is connected, is driven up and down by the latch on the levers above. In Fig. 25, the shaft which drives the crank #2,

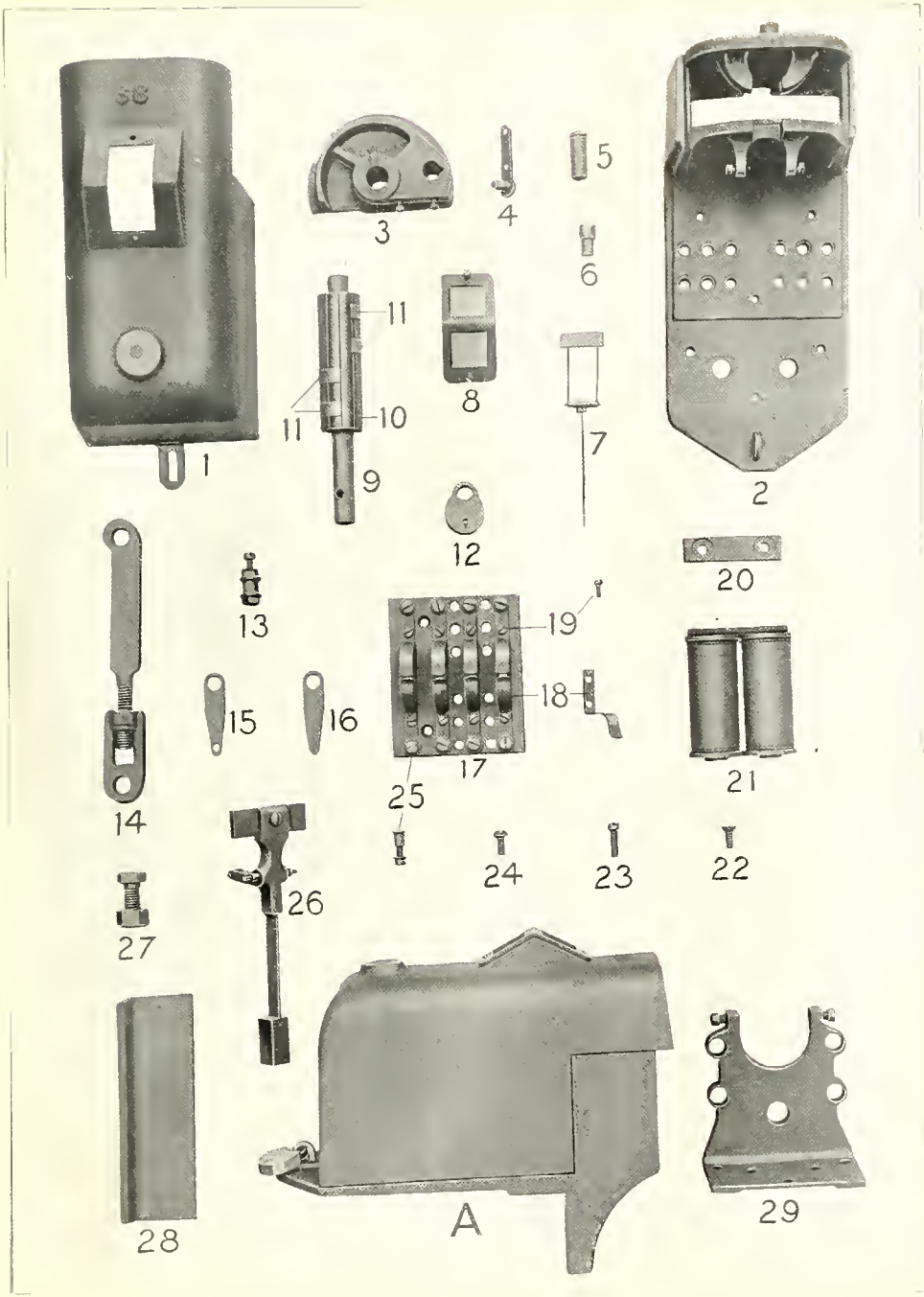

Fig. 23

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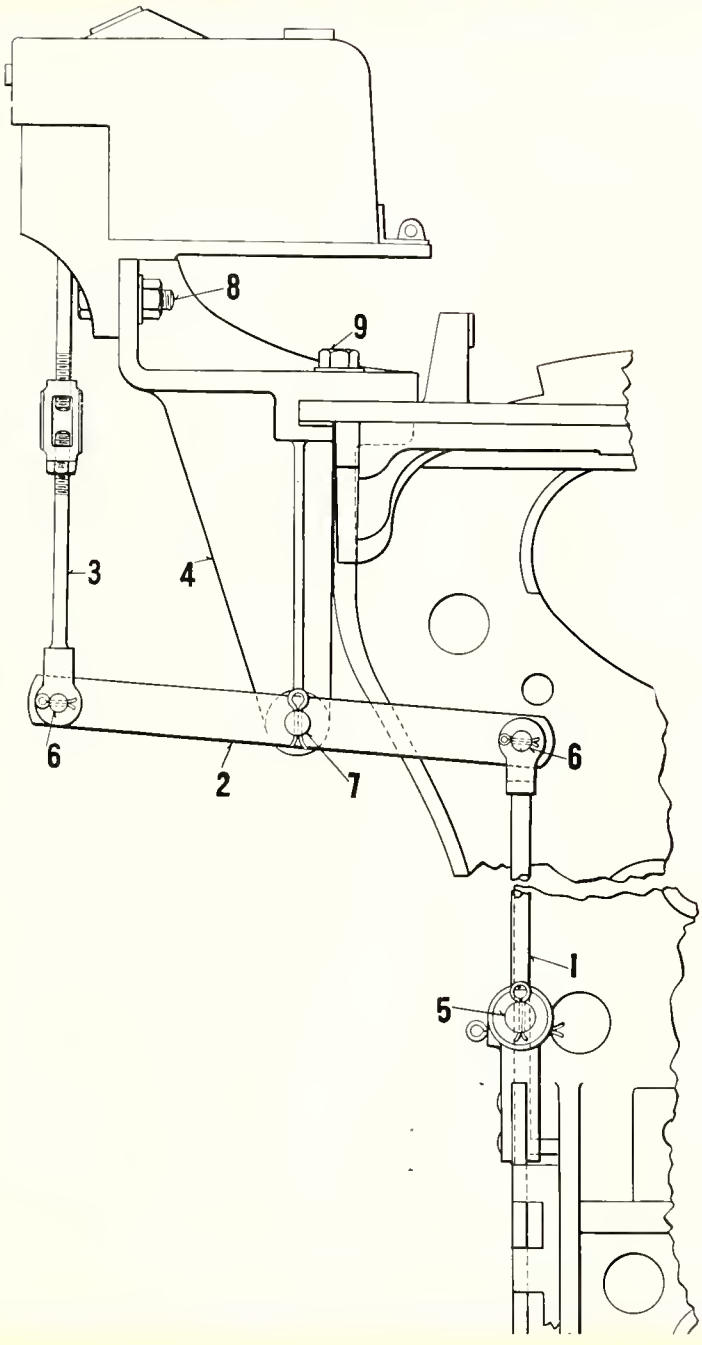

Fig. 24

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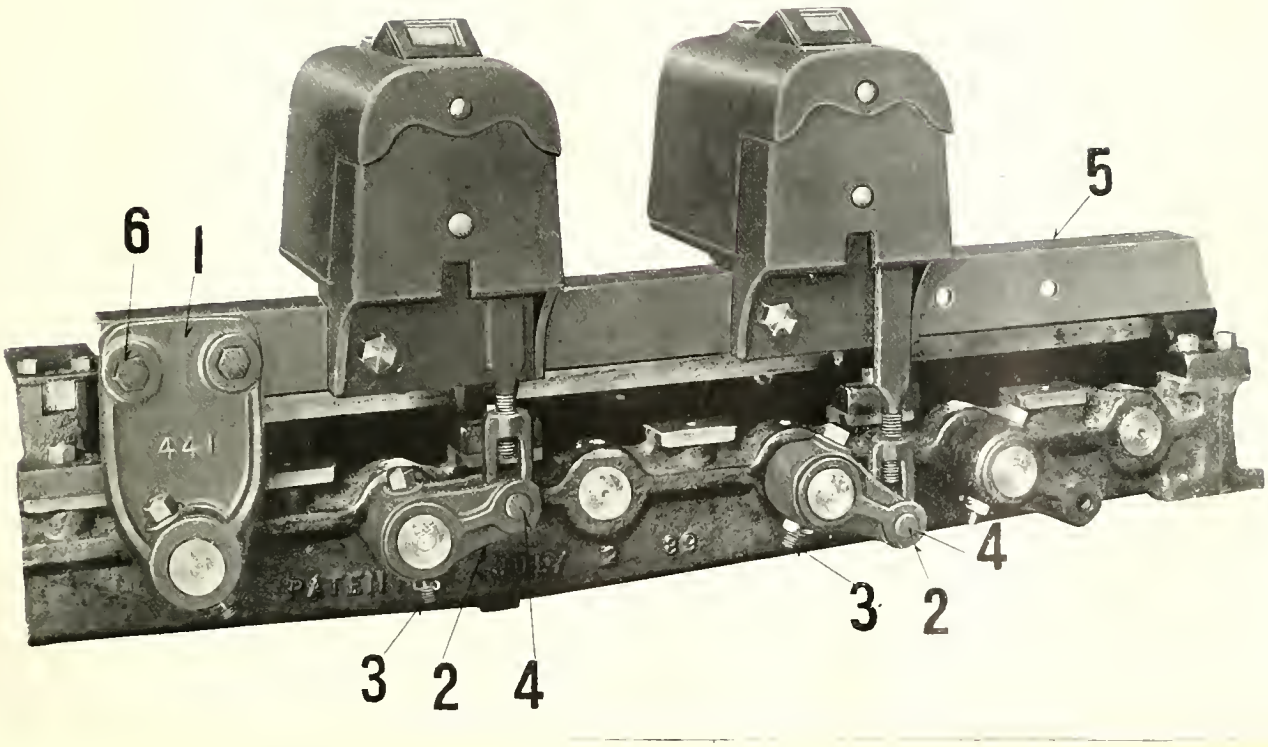

Fig. 25

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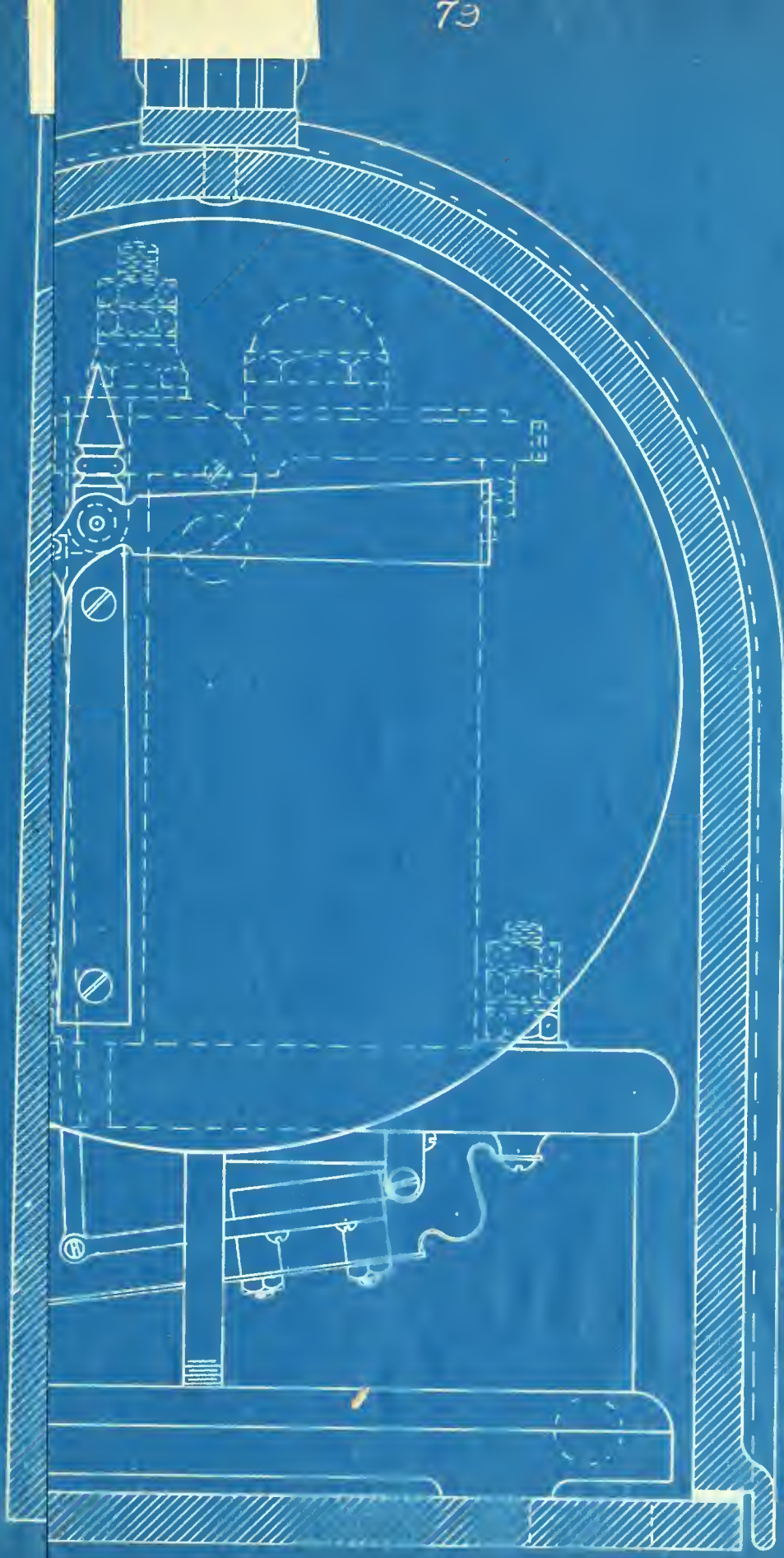
connected to the lock disk by the link 11a, Fig. 25, is rotated by the latch of the lever. This shaft also drives the mechanical locking of the machine. The lock to the left is shown in the locked position; while the lock to the right is shown in the position with lever reversed, and latch down.

The Tower Indicator is shown in Fig. 26, page 79. A is a side elevation with the case in section, and B is a front elevation with case in section. This indicator will be recognized as the standard relay, described previously, enclosed in an iron case, with a connection to its armature to operate the miniature signal blade which is placed behind a glass front, as in the case of the switch indicator. With the detailed description of the relay itself fresh in mind, Fig. 26 will explain itself.

The Hand Release, or more correctly termed Electrical Screw Release, is shown in Fig. 27, page 80. It consists simply of a speed reducing combination of a worm and worm wheel, which drives the contact strips, which connect a brush on one side with a brush on the other, completing a circuit. The whole, with the exception of the crank, is enclosed in an iron case and locked or sealed.

In Fig. 27, the crank, a, drives the worm, b, which in turn drives the worm wheel, c. On the worm wheel shaft, d, and driven by the worm wheel, is the crank stop, e, attached to c by screw, f, for driving purposes only. On the hub of e is fixed the hard rubber collar, g, which carries the contact strip, h. The brushes, i and j, slide



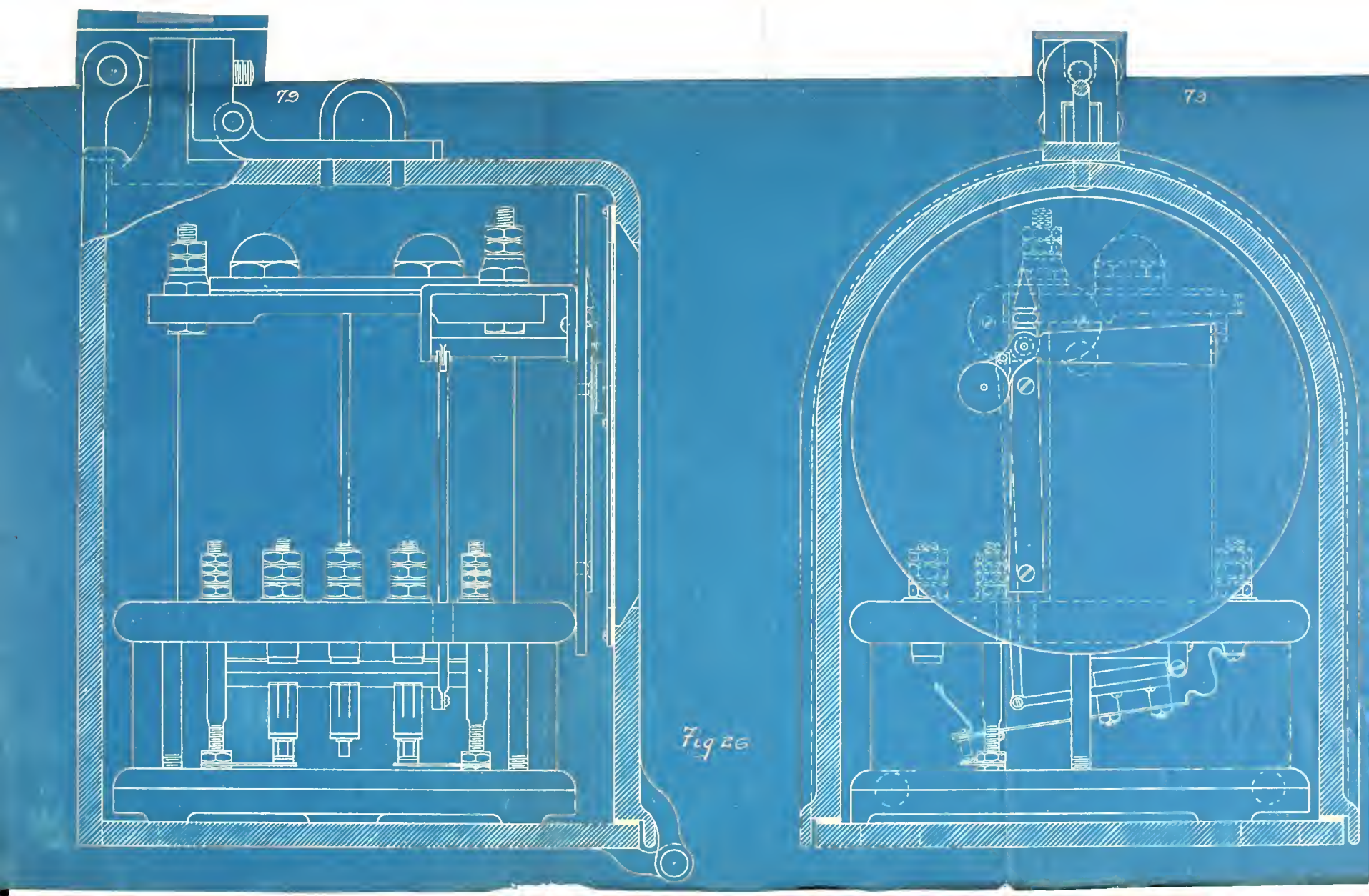


Fig 26

ARMOUR
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Fig 27

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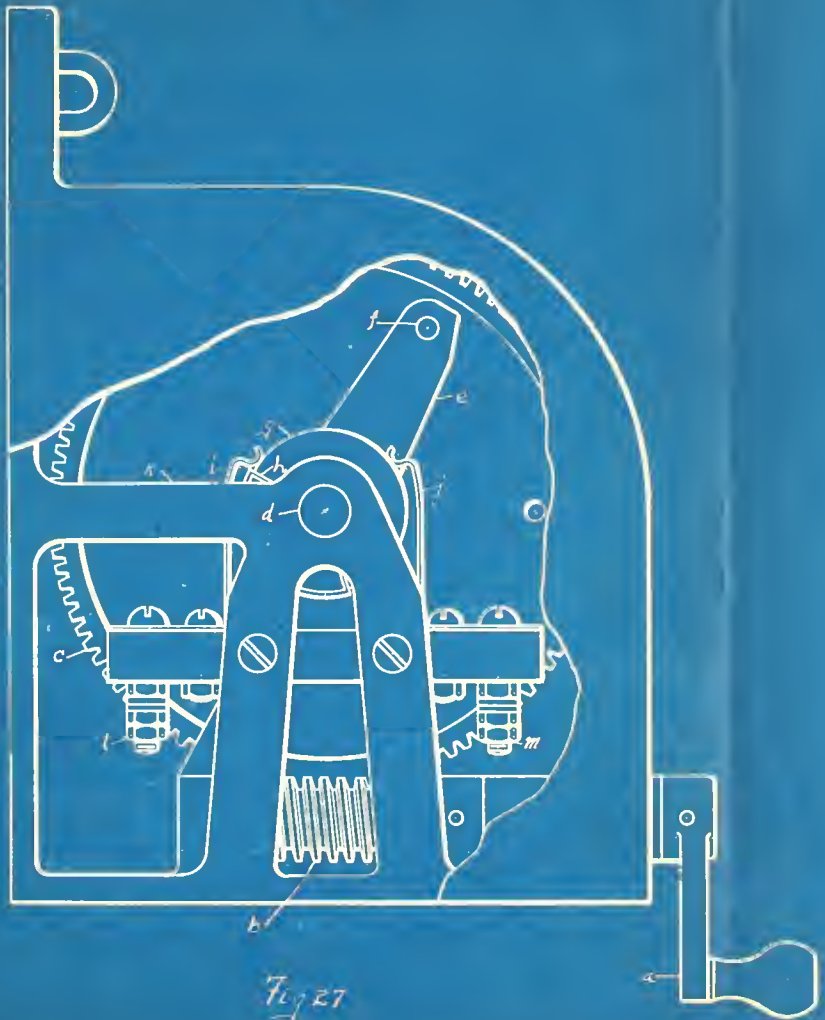

Fig 27

ARMOUR
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on the circumference of the hard rubber collar, and the connected through the strip, h, when it turns to the proper position. They are mounted on the frame, k, and connections are made to them through binding posts, l and m. The contact strip, h, is so placed relative to e that it connects brushes, i and j, just as e strikes a stop on the frame as it rotates to the right.

On the hub of worm wheel, c, on the opposite side are mounted a hard rubber collar and brushes, duplicates of collar, g, and brushes, i and j. Its contact strip is so arranged that it makes contact between the two brushes only when wheel, c, is rotated to the left until a stop lug on its side strikes a lug on the frame. Thus the two extreme positions. When wheel, c, is rotated to the left as far as it will go, the circuit on the opposite side of the wheel is closed; but when wheel, c, is rotated to the right, this circuit is immediately broken, and, at the point where the rotation is stopped by the crank, e, the circuit is closed between i and j. The normal position is with wheel, c, rotated to the left as far as it will go, thus keeping circuit closed. One complete operation consists of starting at normal position and rotating to right until stopped, then returning to normal. Holes are provided every 60 degrees for adjusting the stop arm, e, so that by turning crank, d, as fast as possible by hand, a complete operation will require ten, twenty, thirty, forty, fifty and sixty seconds for the six different positions permitted.

The application of this electrical screw release will be pointed out in the discussion of the circuits following.

The different parts, their application and their duties have been thoroughly discussed in the preceding pages. All the important features of each, as adapted to a system, the sole purpose of which is safety, have been emphasized. The principles used in the wiring and circuits have been explained. In closing, a complete diagram of the circuits, showing local and line connections, is submitted in Fig. 28, page 83. These circuits were worked up and drawn in every detail by the author, to fulfill the terms of the contract and specifications as submitted by the Railroad Company. Only a few special explanations are considered necessary to enable the reader to trace out the different circuits in a satisfactory manner.

Attention is first directed to the table of conventions on the face page of the circuit diagram. These, with those already pointed out in the discussion of Figs. 4, 5 and 17, cover all conventions used in the diagram. Instead of drawing the detail connections for each signal, as shown in Fig. 5, the 45 degree or caution position and 90 degree or clear position have been shown in diagramatic form and marked 45 and 90 respectively. All of the main operating batteries have been shown in duplicate sets, representing the storage battery and its charging set of gravity battery. The simple circuits for the straight automatic signals have been explained in Fig. 5, so that

CIRCUITS
C.& W.I.R.R.

HAMMOND JUNCTION TO STATE LINE TOWER.

SIGNALS LOCATED FROM BLUE PRINT 1350.

ELECTRIC SEMAPHORE SIGNALS.
Automatic and Semi-Automatic.

Three Position Electric Block Signal.

Three Position Electric Semi-Automatic, lower arm operated mechanically.

Three Position Electric Semi-Automatic, lower arm fixed mechanically.

Switch and Tower Indicator.

× Indicates that Switch Box to be placed at Switch.

Lightning Arrester.

(3/7) Relay Box on battery chute post. Top number inside represents batteries, Bottom number repeesents number of relays.

(3) Battery chute, Number inside represents number of cells the chute will hold.

Fig 58

CSC

CONTINENTAL SIGNAL COMPANY

Drawn H.E.B.	T-202	Traced F.H.L.

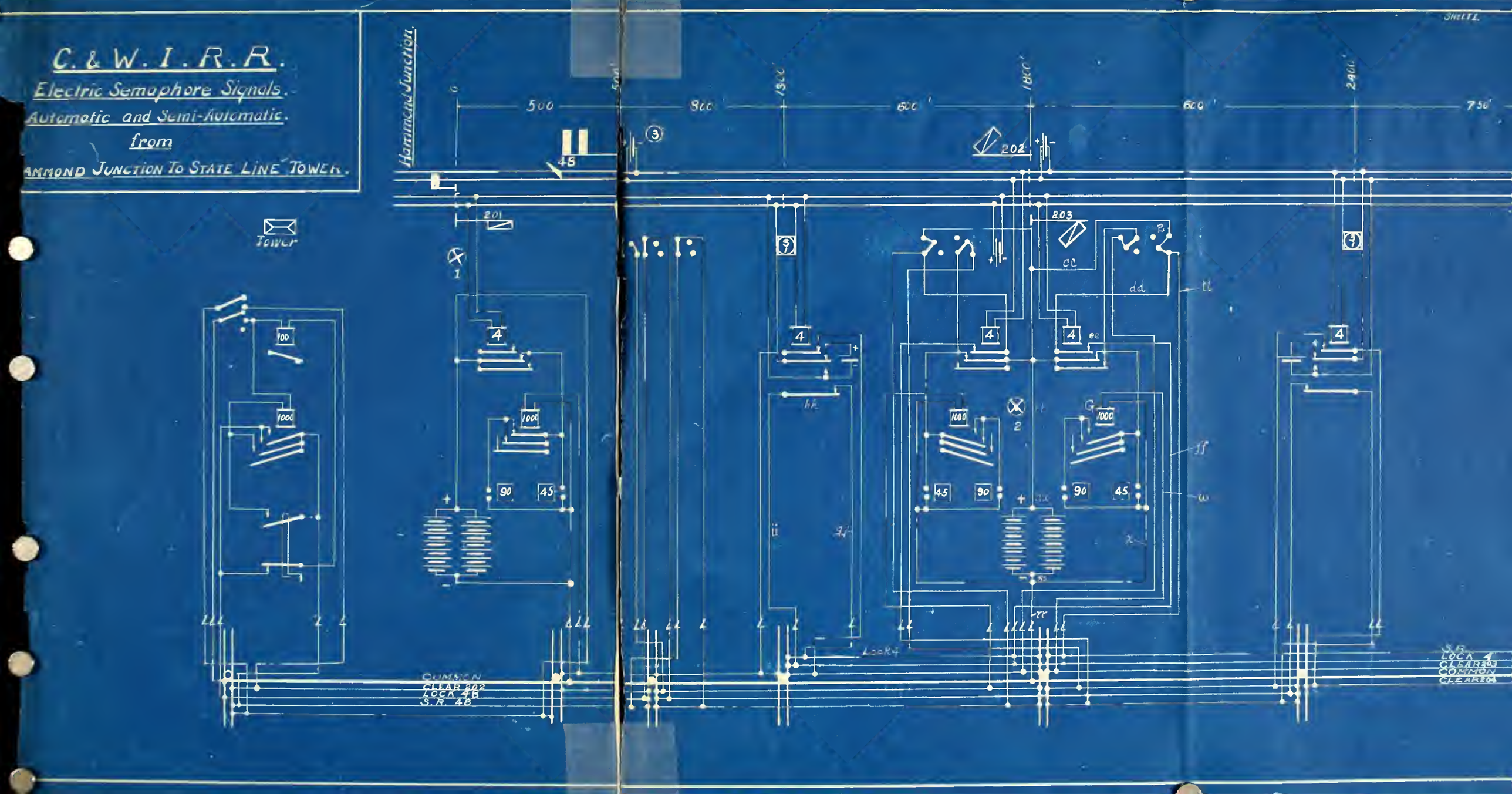
C. & W. I. R. R.

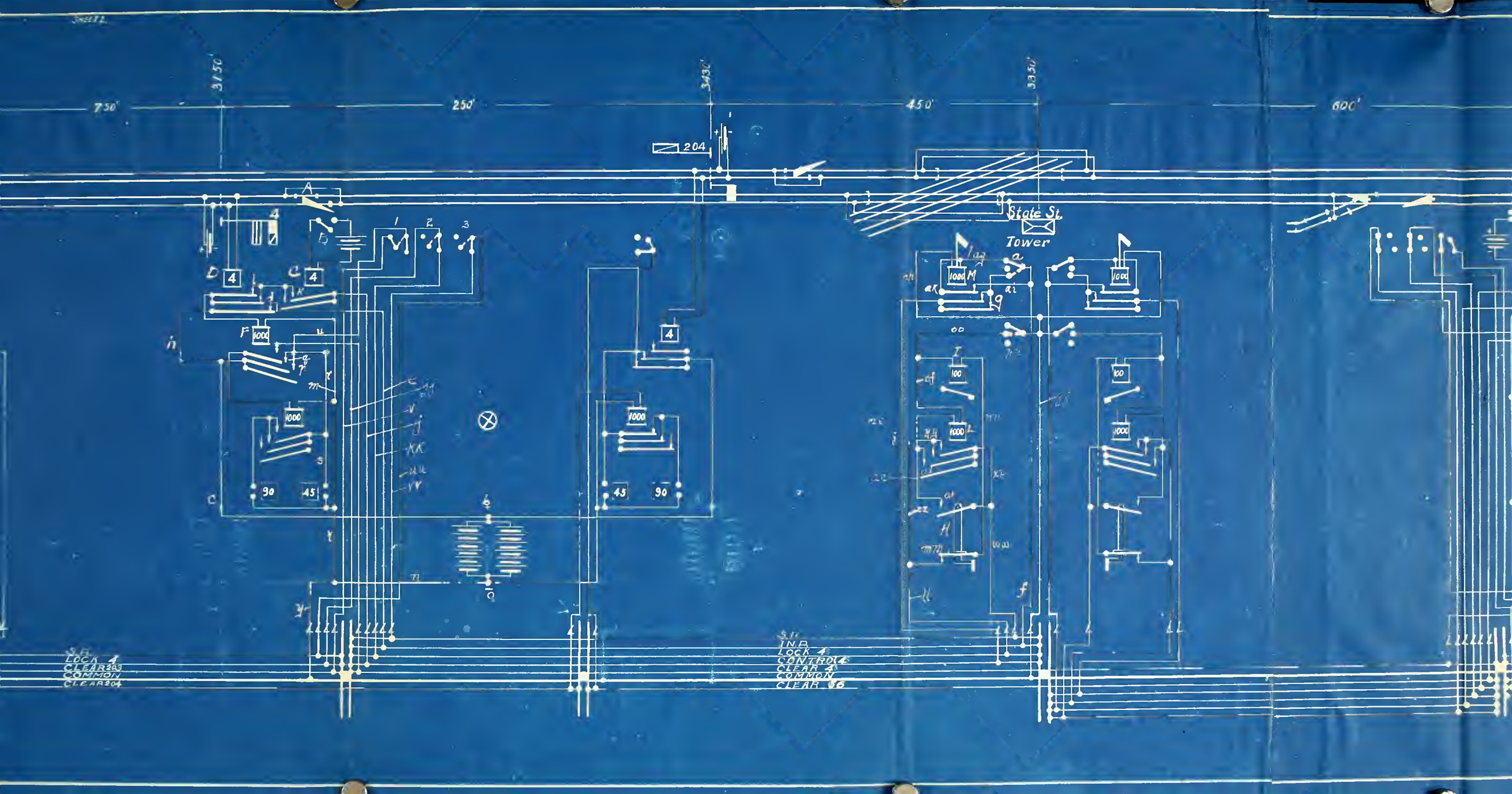
Electric Semaphore Signals.

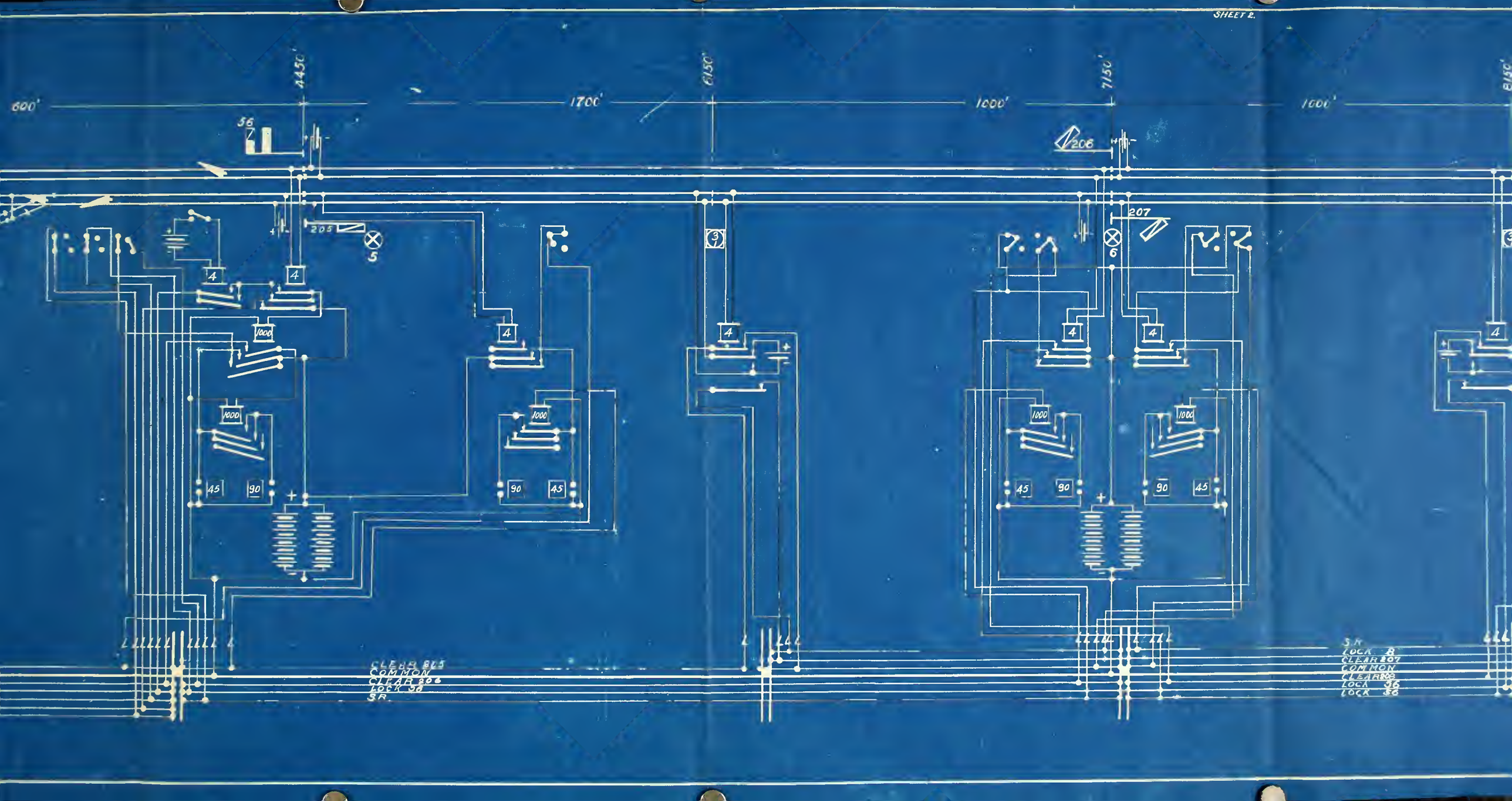
Automatic and Semi-Automatic.

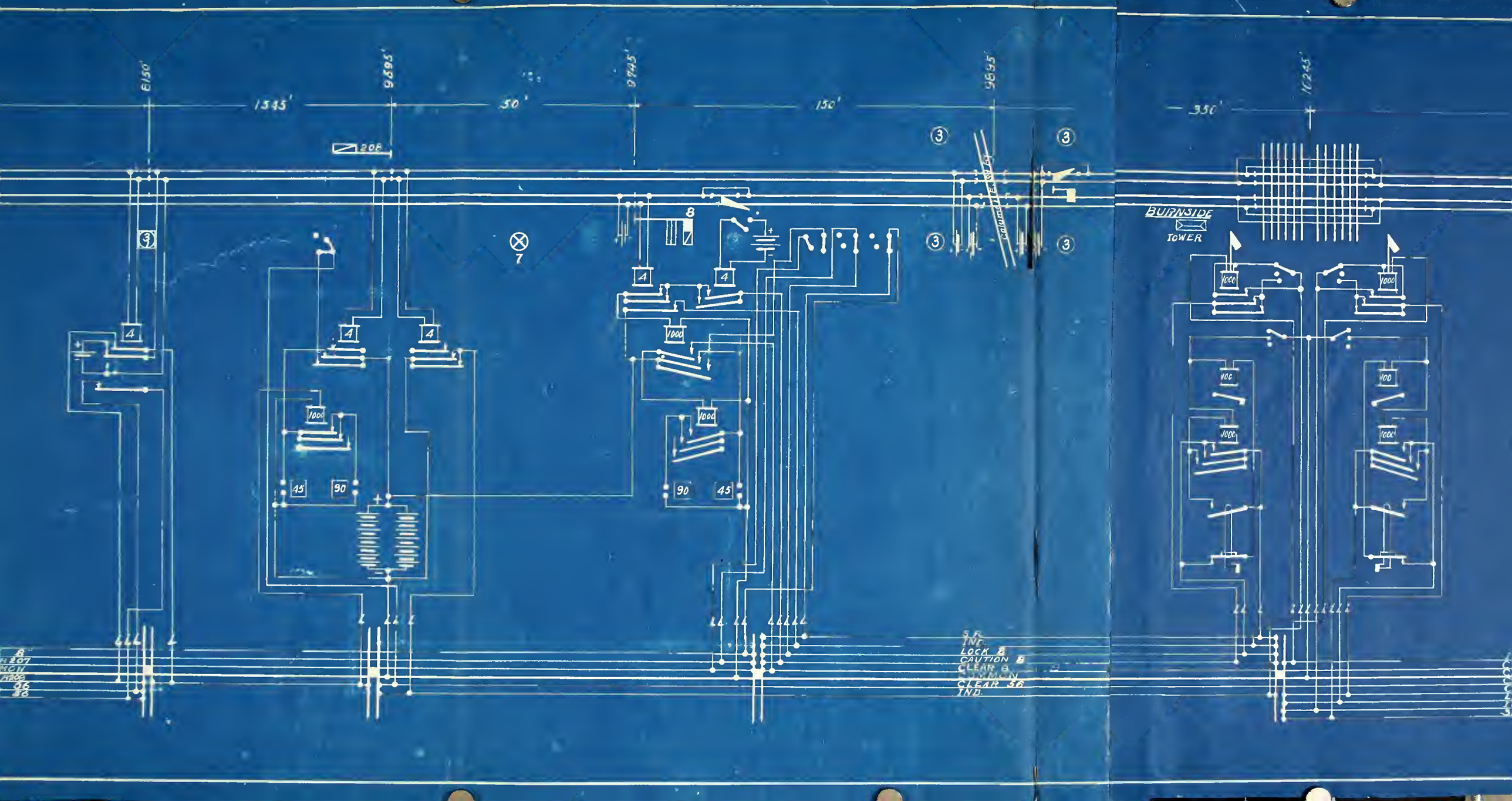
from

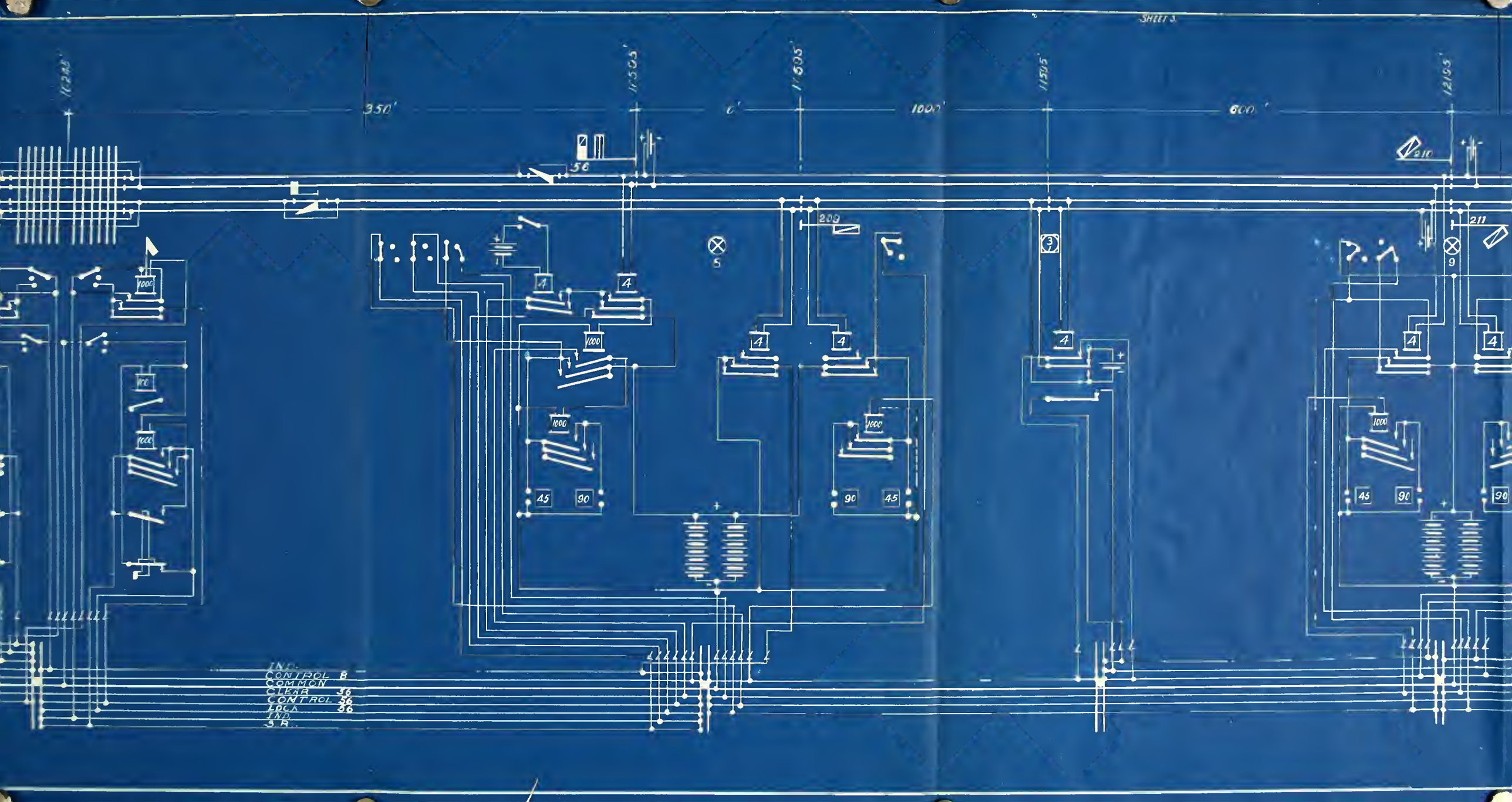
HAMMOND JUNCTION TO STATE LINE TOWER.

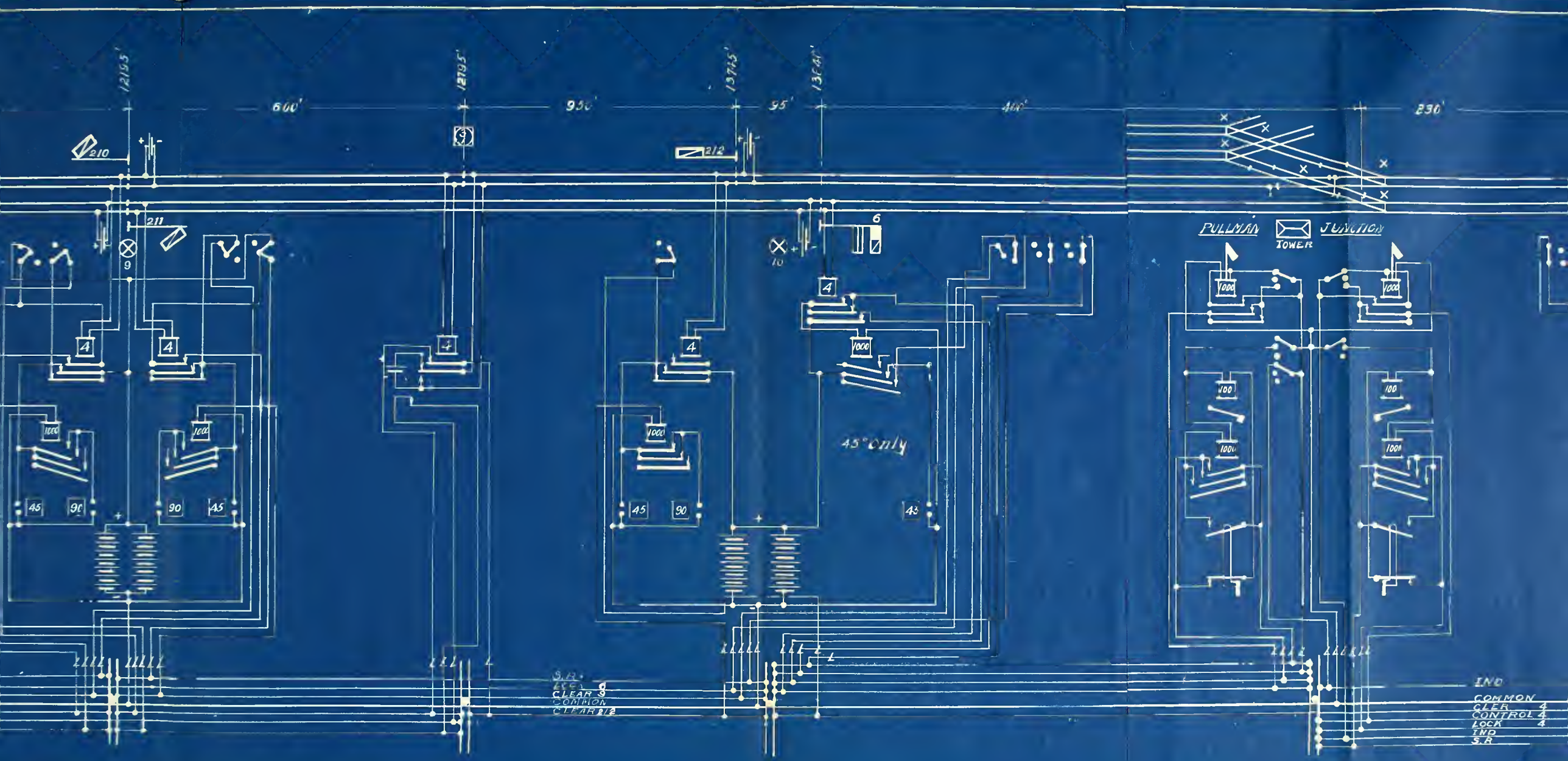


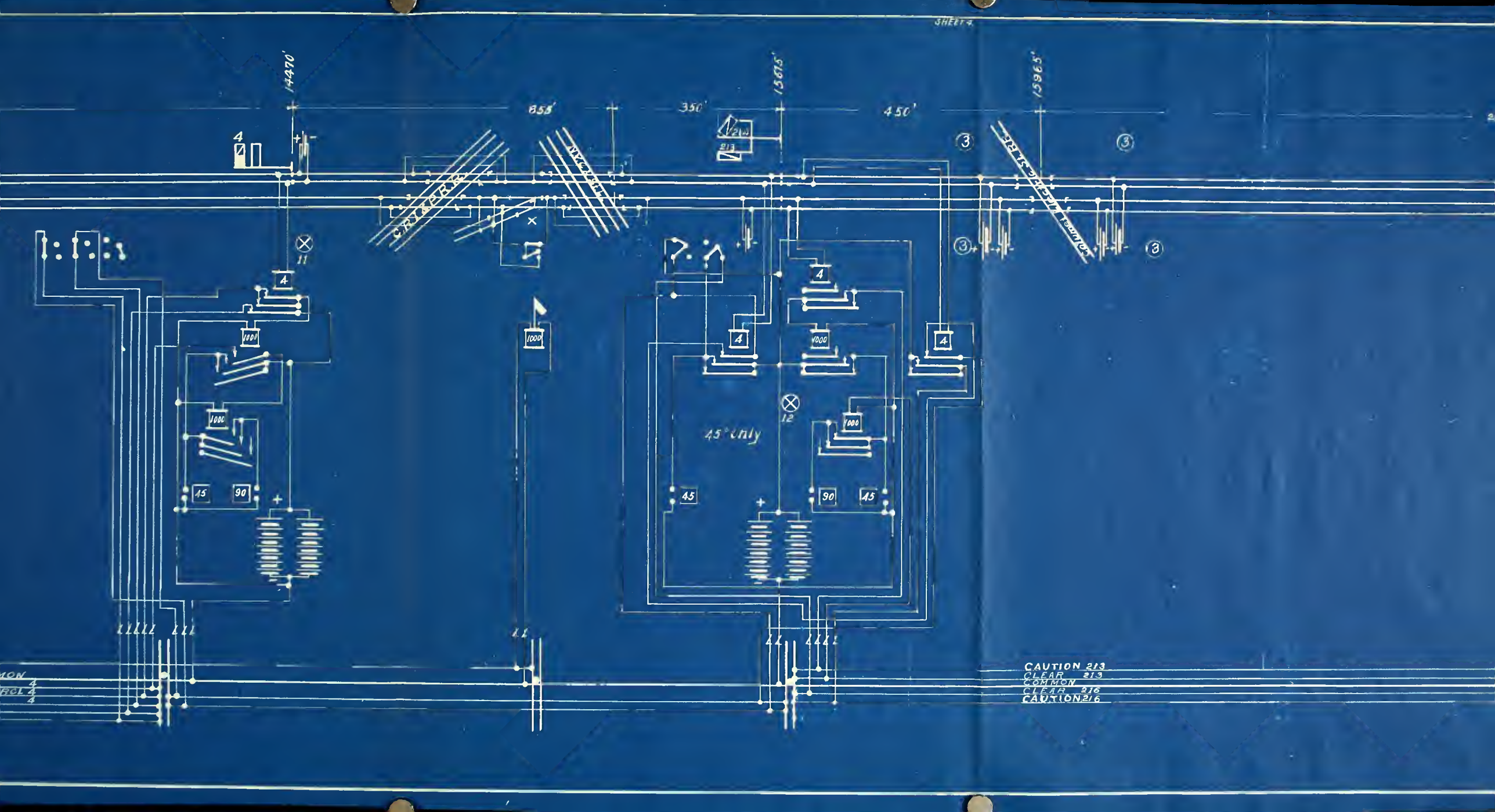

750'
315'
250'
343'
450'
335'
600'
204
State St
Tower
A
B
C
D
F
1000
1000 M
100
90
45
4
1
2
3
S.F.
LOCK 4
CLEAR 203
COMMON
CLEAR 204
S.F.
INB.
LOCK 4
CONTROL 6
CLEAR 4
COMMON
CLEAR 86

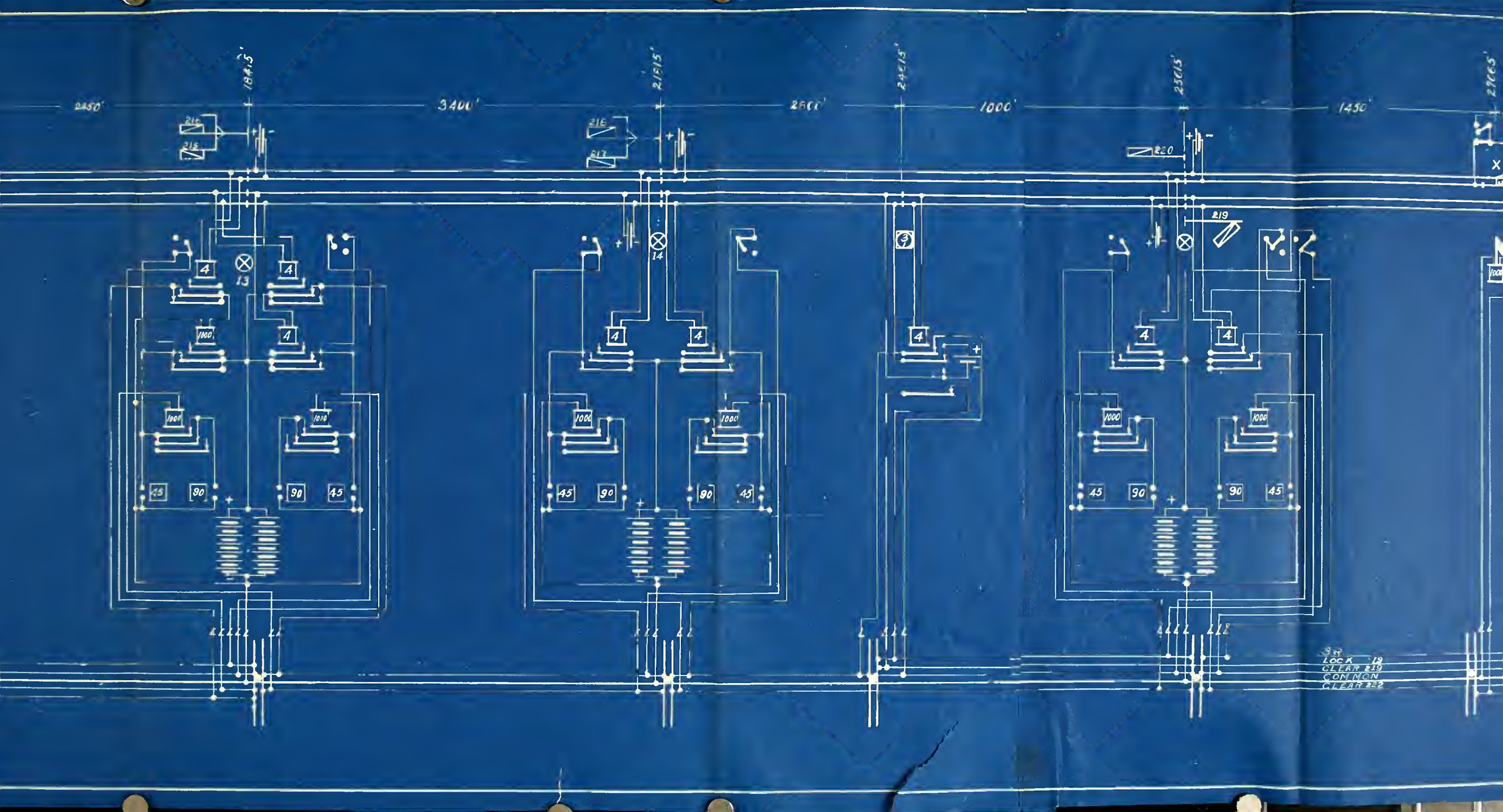

600'
445'
1700'
615'
1000'
715'
1000'
56
205
5
4
1000
45
90
206
207
6
CLEAR 805
COMMON
CLEAR 206
LOCK 56
SR
SR
LOCK 8
CLEAR 807
COMMON
CLEAR 808
LOCK 56
LOCK 56

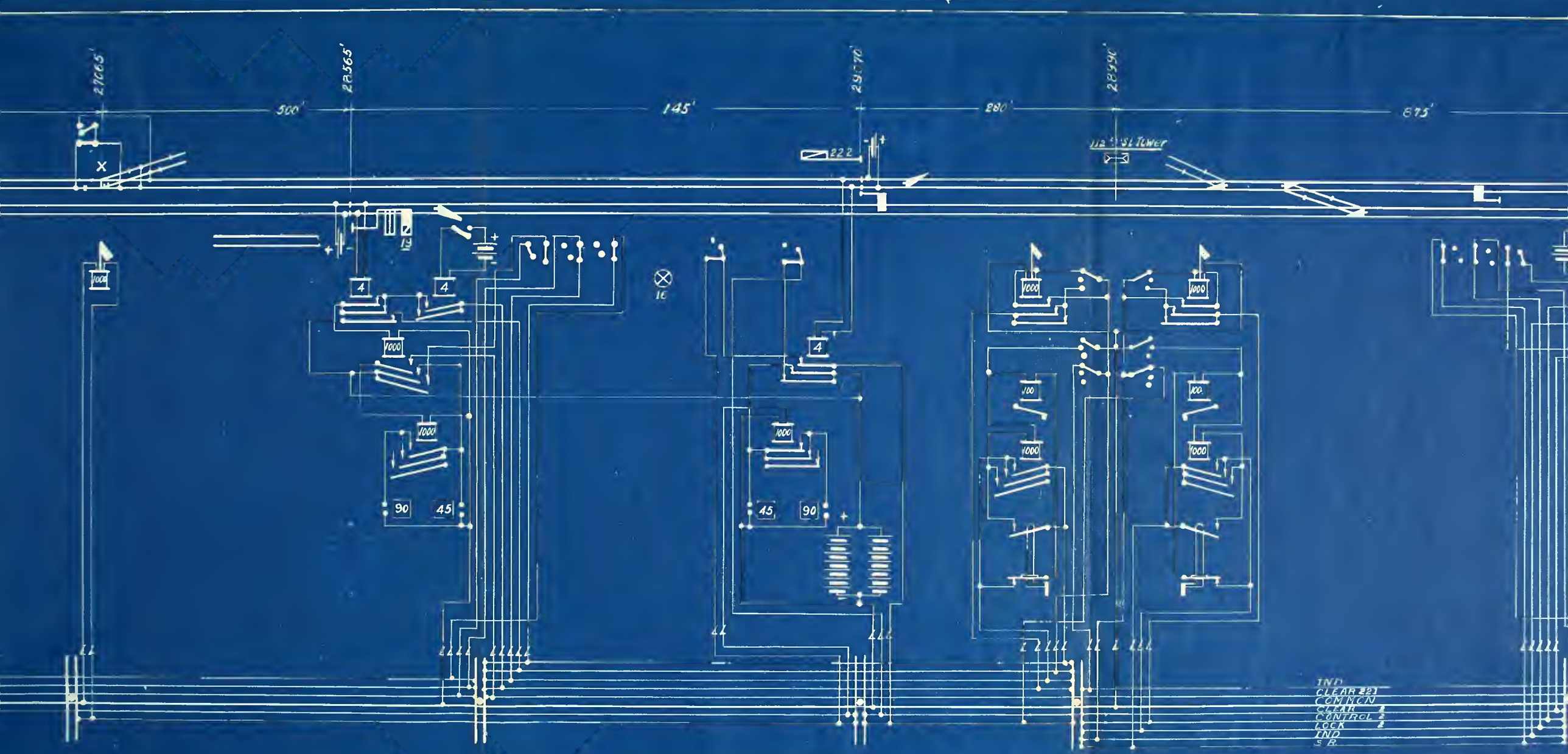

8150'
1545'
9695'
50'
9745'
150'
9695'
350'
16245'
20P
BURNSIDE
TOWER
CONCRETE SILO
S.F. IND.
LOCK & CAUTION & CLEAR & COMMON CLEAR 36 IND.
1000
45
90
4
3
8
7

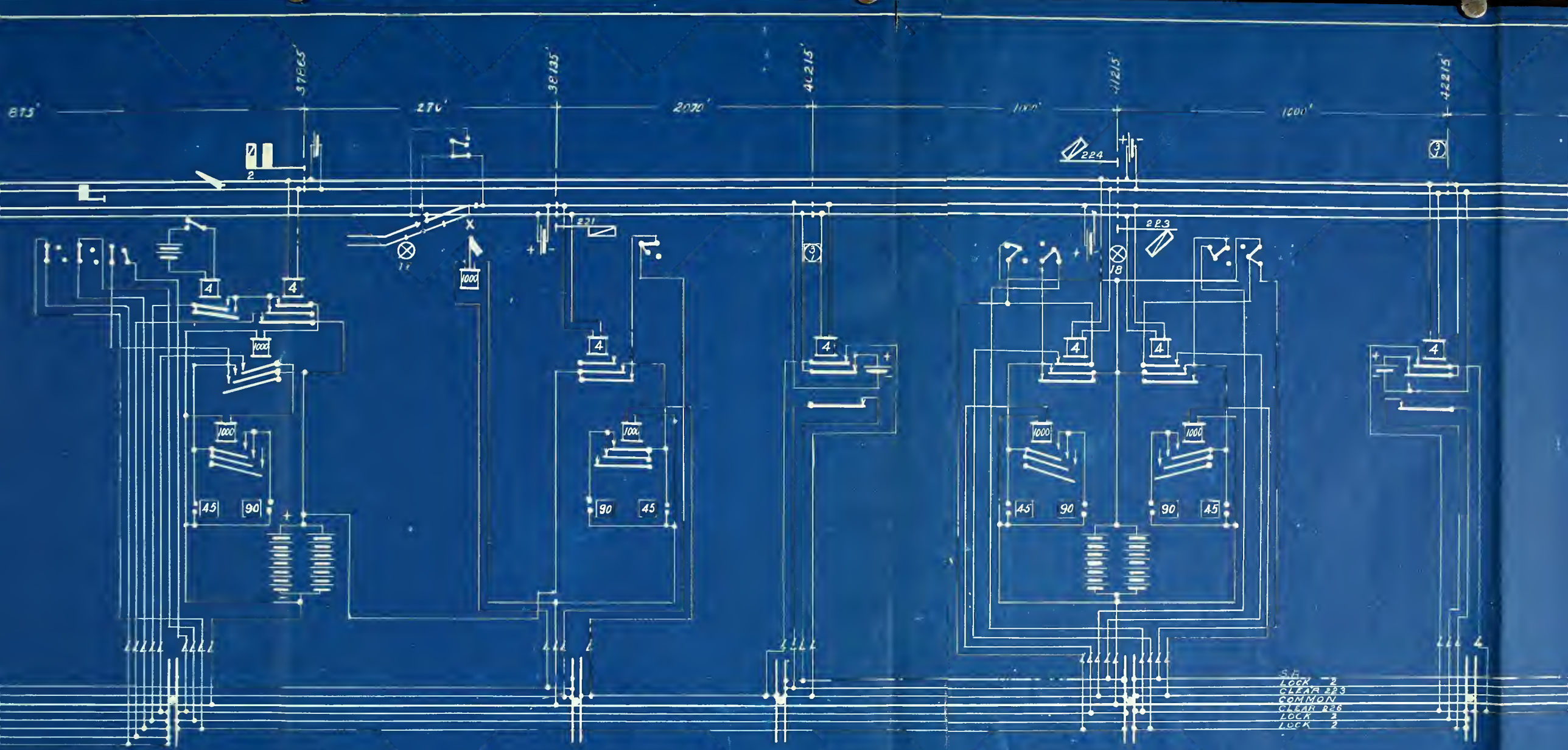

1248'
350'
1505'
0'
1505'
1000'
1505'
600'
1203'
56
209
210
211
5
3
9
4
1000
100
45
90
IND.
CONTROL 8
COMMON
CLEAR 56
CONTROL 56
LOCK 56
IND.
S.R.

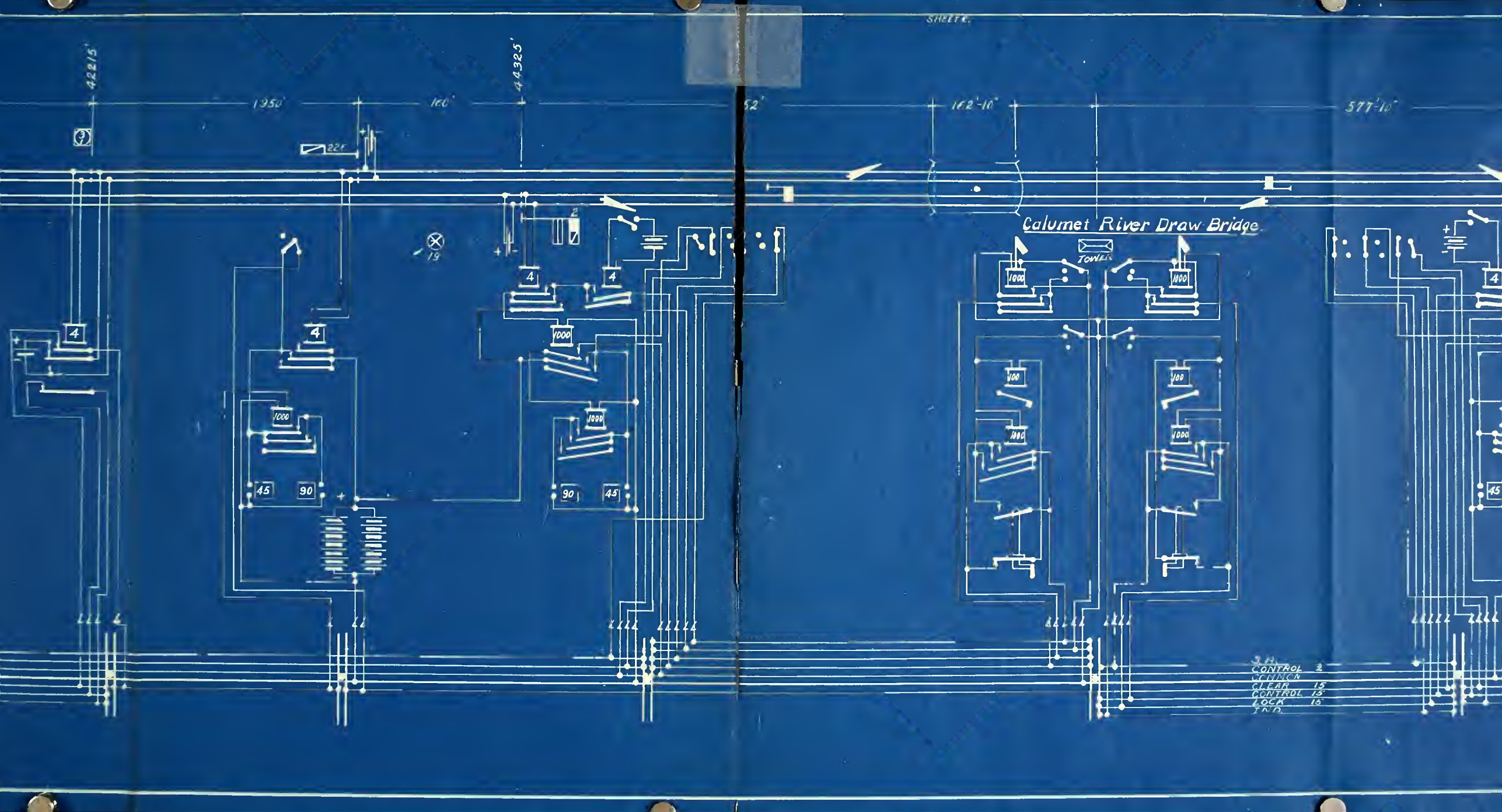

12155'
600'
12795'
950'
13745'
95'
13841'
440'
230'
210
211
212
9
10
6
4
1000
100
45
90
45° only
PULLMAN
TOWER
JUNCTION
S.R.
CLEAR 9
COMMON
CLEAR 212
IND
COMMON
CLER 4
CONTROL 4
LOCK 4
IND
S.R.

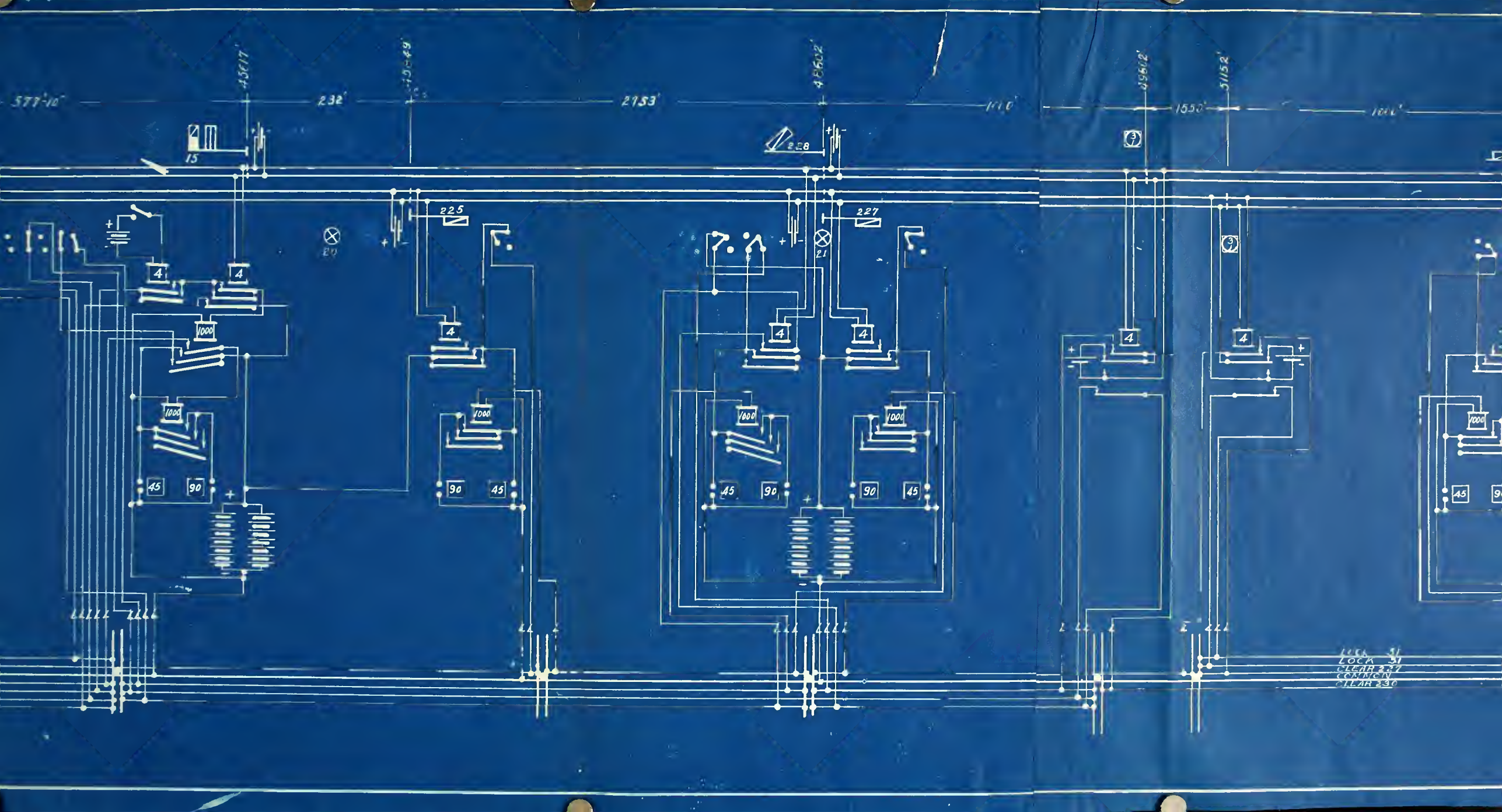

14470'
855'
350'
15615'
450'
15965'
4
213
216
3
11
4
1000
1000
1000
45
90
45
1000
4
4
4
4
12
45 only
45
90
45
CAUTION 213
CLEAR 213
COMMON 216
CLEAR 216
CAUTION 216

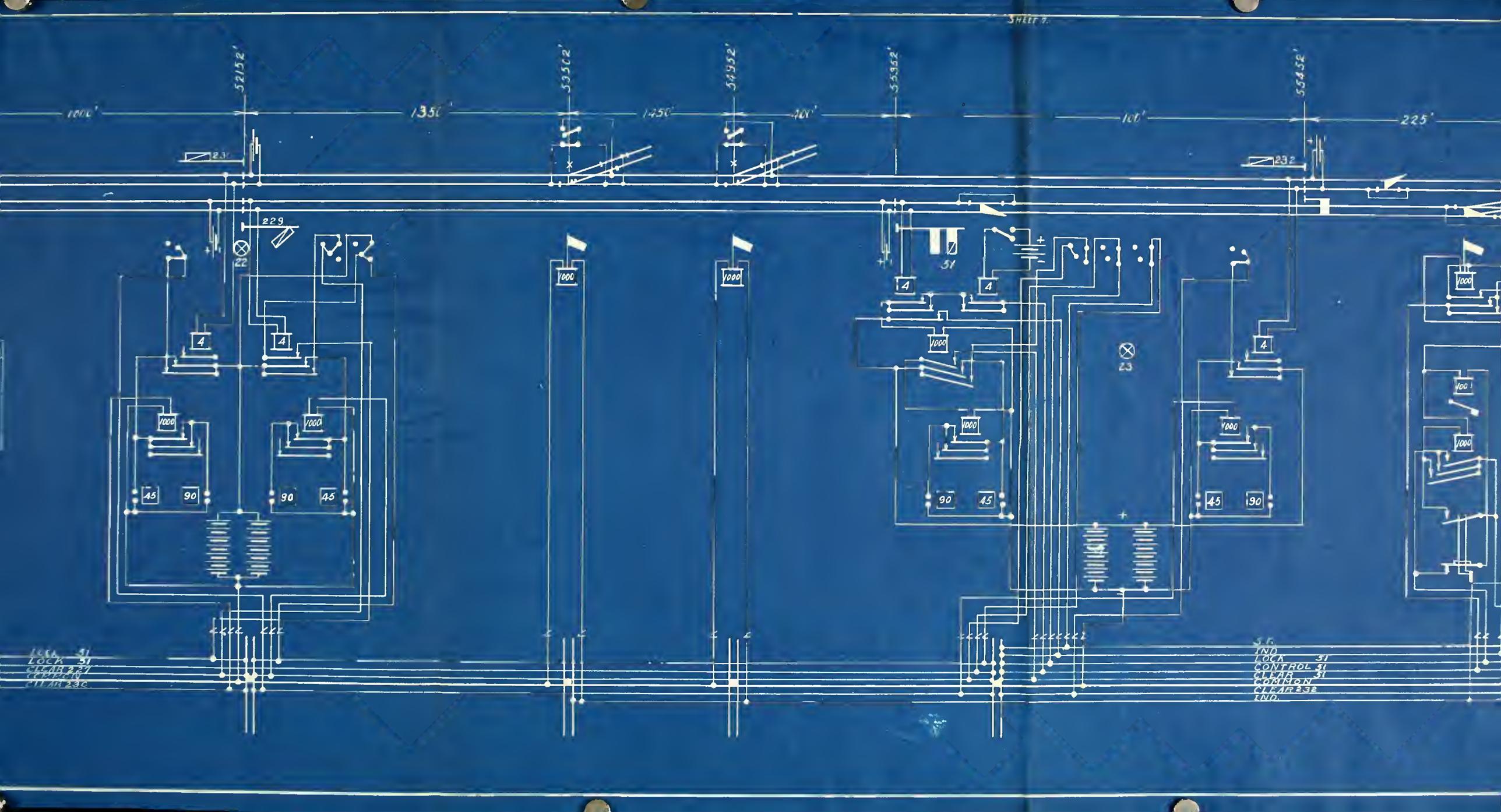

2450'
1845'
3400'
21515'
2600'
24615'
1000'
25615'
1450'
216
215
217
220
219
13
14
4
1000
45
90
LOCK 19
CLEAR 219
COMMON
CLEAR 222

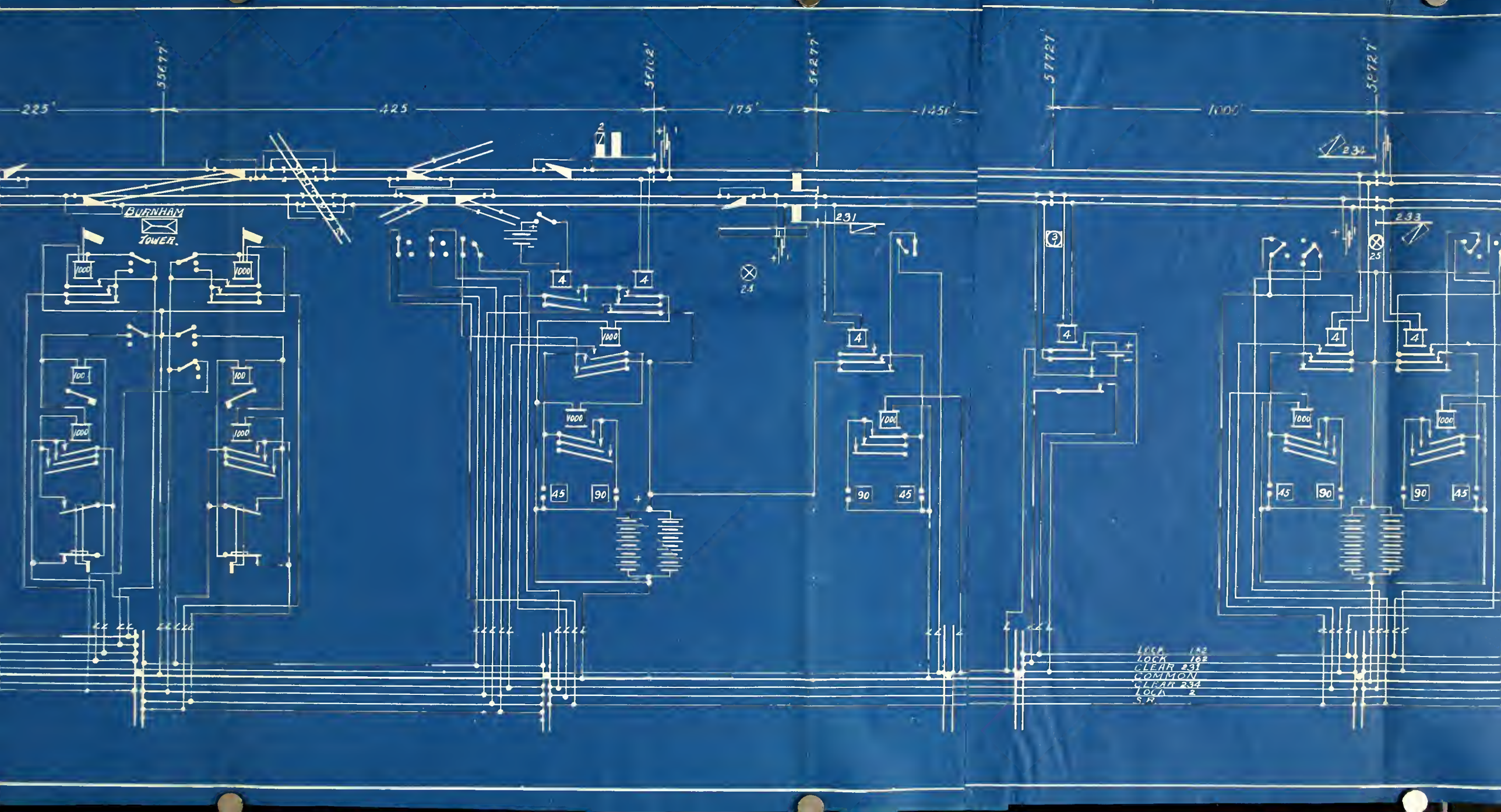

27665'
28565'
29170'
22990'
500'
145'
880'
675'
X
222
112 # 51 Tower
1000
4
90
45
100
IND
CLEAR #21
COMMON
CLEAR 1
CONTROL 2
LOCK 2
IND
SR

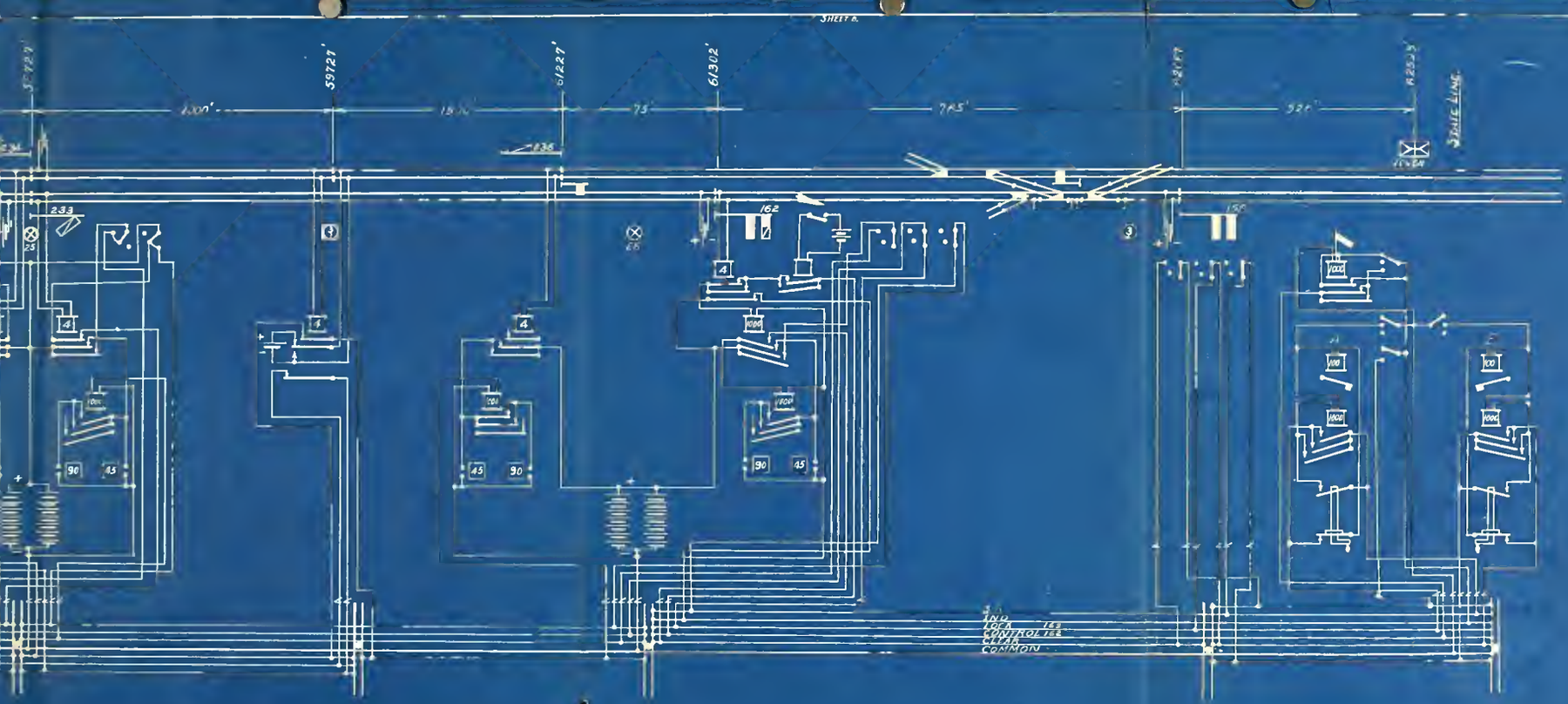

875'
37+65'
270'
38+35'
2070'
40+15'
1000'
41+15'
1000'
42+15'
224
223
221
2
1
18
4
1000
100
45
90
SE
LOCK 2
CLEAR 223
COMMON
CLEAR 226
LOCK 1
LOCK 2


42215'
1950'
160'
44325'
52'
162'-10"
577'-10"
Calumet River Draw Bridge
TOWER
22F
19
4
1000
45
90
100
400
S.H.
CONTROL 2
COMMON
CLEAR 15
CONTROL 15
LOCK 15
IND.


577'-10"
45617'
232'
-15-49'
2153'
48602'
1110'
49612'
1550'
51152'
1000'
15
228
225
227
20
21
4
1000
45
90
LOCK 31
LOCK 31
CLEAR 237
CLEAR 236


52152'
53502'
54952'
55352'
55452'
1000'
1350'
1450'
400'
100'
225'
23
229
232
51
1000
4
45
90
LOCK 51
CLEAR 227
CLEAR 230
IND.
LOCK 51
CONTROL 51
CLEAR 51
COMMON
CLEAR 232
IND.


55677'
225'
425'
56102'
175'
56277'
1451'
57727'
1000'
56727'
BURNHAM
TOWER.
1000
100
45
90
4
231
234
233
24
25
LOCK 182
LOCK 162
CLEAR 231
COMMON
CLEAR 234
LOCK 2
S.P.



CIRCUITS
C&W.I.R.R.

HAMMOND JUNCTION T. STATE LINE TOWER

SIGNALS LOCATED FROM STATE LINE TOWER EAST

ELECTRIC SEMI-HOME SIGNALS
Automatic and Semi-Automatic

- Three Position Electric Block Signal.
- Three Position Electric Semi-Automatic, lever operated mechanically.
- Three Position Electric Semi-Automatic, lever controlled mechanically.
- Switch and Lever Indicator.
- X Indicates that Switch is Electrically Locked.
- L Lightning Arrester.
- Relay Box & battery chute post. Top number inside represents batteries, Bottom number inside represents number of relays.
- Battery chute. Number inside represents number of cells the chute will hold.

CSC

CONTINENTAL SIGNAL COMPANY

Drawn		T-202	
H.E.F.			

these will be traced out on the main diagram without difficulty. In order that the connections for the semi-automatic and the tower wiring may be as clear, the circuits for automatic signal #203 and semi-automatic signal #4 at State Street Interlocker, with their connections in the tower, will be taken up in detail.

Signal #4 stands normally at 'stop', being a semi-automatic signal. Therefore, the automatic signal #2.5 must stand normally at "caution", as pointed out under Fig. 5. In the same manner, signal #4 depends on signal #2.5 for its clear position. The caution position of signal #4, considering its block unoccupied, is directly under the control of the towerman; while its clear position is only indirectly under the towerman's control.

With the block in front of signal #4 unoccupied, the conditions necessary to place it in operation are as follows: Towerman must line up the route governed by signal #4 through the interlocking plant so that the lever will be released as controlled by the interlocking machine itself. Thus, derail, A, is closed, closing the circuit closer in the switch box, B, which causes the relay, C, to pick up, closing its front points. This constitutes the separate derail circuit specified. The towerman then reverses lever #4, and, when its latch goes down in the reversed position, the circuit closer, which is a part of the electric lock as described, moves into the dotted position and the controlling circuit is completed; viz: positive battery, b; wire, c; wire, h; front point, d, of relay, D; wire, e;

line wire L.W.; ire, f; contr , g; [illegible] of tower indicator, h; wire, i; line wire controlled k; [illegible] j; front points, k, of relay, C; front points, l, of rela , D; coils of relay, F; wire, n; wire, r; to negative batter , o. Coils of relay, F, are energized, attracting the armature and closing its front points and the 45 degree circuit; viz.: positive battery, b; wire, c; front point, a, of relay, F; wire, r; wire, s; through 45 degree mechanism; wire, t; wire, n; negative battery, o. This circuit operates the mechanism of signal 4 and pulls blade down to the 45 degree position.

This movement of signal 4 moves its circuit controllers, which are the disks on the main shaft, to the position shown by the dotted line. Disk 1 closes the circuit, while disks 2 and 3 break circuits by this movement. The circuit closed by disk 1 is as follows: positive battery b; wire, c; front contact, p, of relay, F; wire, u; contact disk, 1; wire, y; line wire clear, 2.C; wire, w; coils of relay, G; wire, x; line wire, common; wire, y; wire, n; negative battery, o. This circuit energizes rela , G, closing its front points. This completes the circuit through the 90 degree mechanism of signal 2.C, and its blade is pulled down to the clear position, which breaks its contact 13. The locking circuit which provides protection for both the towerman and the engineer is obtained as follows: positive battery, aa at signal 2.C; wire, bb; wire, cc; contact 2; wire, dd; front point, ee;

wire, ff; line wire, lock; wire, gg; front point, [illegible]; wire, ii; line wire, lock 4 to signal 4; wire, jj; contact, 2; wire, kk; line wire, lock 4 to tower; wire, ll, closed point, mm, of screw release, H; wire, nn; through coils of lock, I; through wire, oo; contact, pp; which is included in the electric lock, I; wire, qq; line wire, common; wire, rr; negative battery, ss; at signal 203. By following through this circuit, it is evident that in order to energize the coils of lock, I, the short track section in front of signal 203 must be unoccupied. The track section governing the caution position of signal 203 must be unoccupied and the blade itself must be in some position between the horizontal and the caution position; also, on account of contact 2 of signal 4, the blade of 4 must be in a stop position and the latch on lever 4 controlling contact, pp, must be raised or half-reversed. From this, it is seen that if lever 4 in the tower be reversed, operating signals 4 and 203 as described, it may be put back to the normal position, returning signals 4 and 203 to their normal positions at any time. If no train has, in the meantime, passed into the short section in advance of signal 203, the locking circuit is completed if signals 4 and 203 do return to their normal position and lock, I, is energized, releasing the latch of lever 4 and allowing it to go down. However, if a train has passed into the advance section, the track relay of this section opens, breaking the locking circuit and holding it open until the

back end of this train has passed signal 4. The lever may be returned to its normal position at any time, returning signals 4 and 203 to their normal position, but the locking circuit is still held open by the train, and the latch in the normal position is locked up. It must be remembered that when the latch of a signal lever is up, all levers controlling switches and derails governed by this signal are locked in the safe position.

For cases of emergency, the screw release circuit is provided, which will permit the releasing of the lock if the track sections named are occupied, after the elapse of from ten seconds to one minute. This time is required to take the screw release through one operation, as described above. This circuit is as follows: positive battery, aa, at signal 203; wire, bb; wire, cc; contact, 2; wire, tt; line wire, sr, to signal 4; wire, uu; contact 3, vv; line wire, sr, to tower; wire, ww; wire, xx; front points yy, of stick relay, L; wire, zz; from contact, mm, of screw release, H; wire, nn; coils of lock, I; wire, oo; contact, pp; wire, qq; line wire, common; wire, rr; negative battery, ss.

A stick relay may be defined as one which, if the coils be energized from one circuit, closes, by means of one of its front points, another circuit which will continue to energize its coils, although the first circuit be broken. Thus, the means provided in the screw release circuit for closing the front point, yy, is the reverse

contact, ab, of the screw release, K. Therefore, to pick up stick relay, L, screw release, K, is reversed, closing contact, ab, by breaking contact, mm, and the screw release circuit from wire, ww, passes through contact, ab; wire, ac; coils of relay, L; wire, af; wire, oo; contact, pp; wire, qq; and back to common. This circuit picks up relay, L, and the holding circuit is made through wire, xx; front contact, ad; wire, ac; coils of relay, L; and so on, as before. It is evident, upon breaking contact, mm, in order to close ab, that the main locking circuit was broken at mm. Therefore, to pick up the lock, I, it is necessary to return screw release, K, to its normal position, closing contact, mm. Stick relay, L, remains closed, however, and as soon as contact, mm, is made, lock, I, is energized and the latch is released; circuit controlling pp returning from the dotted line position to the full line position, breaking the holding circuit of the stick relay L, which opens and will stay open until the next operation of the screw release. It is to be noted that this screw release circuit merely cuts around the track circuits. It is still necessary, in order to operate the screw release circuit, that the signals 4 and 205 be in their normal position.

The one other circuit connected with the tower wiring is that of the tower indicator, which, according to specifications, must indicate the condition of the track section controlling the home signal and must compel the towerman to return his lever to the normal position

after a train has passed the home signal, and then reversing the lever before the signals will again operate. This is accomplished by operating the tower indicator as a stick relay, and the circuit is as follows: positive battery, b, at signal 4; wire, c; wire, h; front point d of relay, D; wire, e; line wire, IMD.; wire, f; circuit control, a; wire, ag; coils of indicator, M; wire, ah; wire, qq; line wire, common; wire, y; wire, n; negative battery, o. This is the normal operating circuit of the tower indicator. if the coils of indicator, m, are energized, its holding circuit is completed through its front contact, ak; its coils; and wire, ah; returning to battery over the same wires as its operating circuit. Thus, when contact, a, is shifted to the dotted position, which is the case when the lever is reversed to clear the signal 4, the tower indicator is held clear as a stick relay. However, when track relay, D, is opened by the passage of the train, front point, d, is broken, opening this holding circuit, and the indicator indicates danger. It is now evident that contact, a, must be returned to its full line position, which is possible when the lever is normal, latch down; and front point, d, of relay, D, must be closed before indicator will again be energized. This means that the track section to which relay, D, is connected, must be unoccupied. The wiring, as traced out above, is practically the same at all interlocking plants.

At the Burnside Interlocking Plant, it is noted that the Calumet Electric Street Railway crosses the Chicago & Western Indiana track inside the interlocking limits. In order that the track battery may feed both directions from this point, it was necessary to make two track sections between signals 208 and 209 on the southbound track, and between 56 and 208 on the northbound track. The slight change in circuits necessitated by this arrangement is easily traced out.

At Pullman Junction, the first switch indicator circuit is encountered. It will be noted that this circuit is merely tapped off from the tower indicator circuit by means of a circuit closer on the electric lock. It, therefore, operates the same as the tower indicator, with the exception that when the latch of lever 56 is lifted, the switch indicator circuit is broken and it indicates danger. It remains in this position until the train has passed signal 213, southbound.

Just south of Pullman Junction, the tracks are again crossed by the Calumet Electric Street Railway, and the track battery feeds in both directions from this crossing.

It has been pointed out why signals 213 and 214, 215 and 216, and 217 and 218 are placed upon the same pole, commonly known as the bracket pole. A working drawing of this bracket pole is shown on page 91, Fig. 29, which will make its construction plain. This same bracket pole is used at signal 19, with one case removed.

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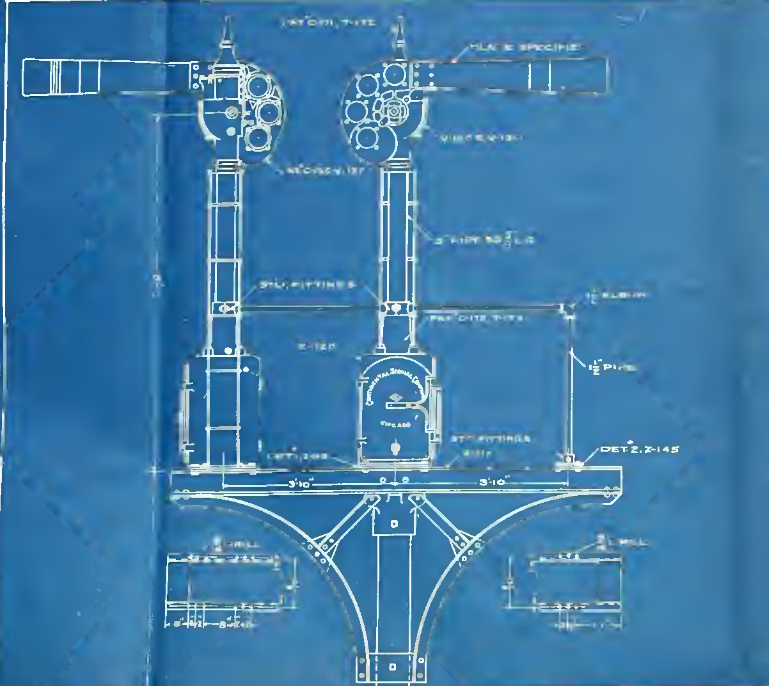

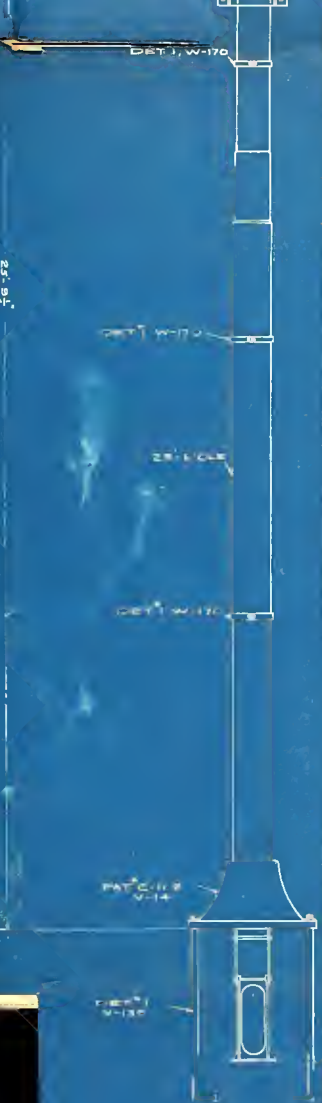

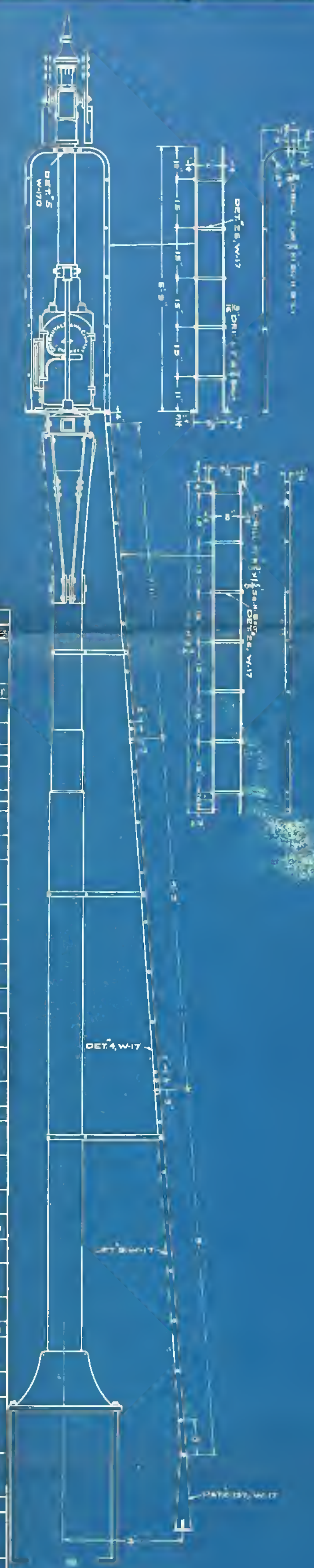

STOCK LIST

ITEM NO.	NO. REQ'D	NAME	DWG. NO.		
	1	BRACKET POLE, PER STOCK LIST, Z-117, WITH DRILLING, PER THIS PRINT, FOR CASES AND HAND RAIL CONNECTIONS	Z-117		
	1	LADDER ANCHOR	W-17	C-137	C-1
	2	BOLTS & NUTS, 3/8x1¼, FOR LADDER ANCHOR	W-17		
	1	9' SECTION LADDER COMPLETE AS FOLLOWS			
		2 BOTTOM SECTIONS		#9	
		7 RUNGS		#26	
	1	8'-9" SECTIONS LADDER COMPLET AS FOLLOWS			
		2 STRAIGHT SECTIONS		#4	
		7 RUNGS		#26	
	1	SPECIAL SECTION LADDER COMPLET AS PER THIS PRINT	W-196		
	2	SPECIAL TOP SEC. LADDER COMPLET AS PER THIS PRINT	W-196		
	22	BOLTS & NUTS, 3/8x1", FOR LADDER SECTIONS, LADDER CLAMPS, & FOR FASTENING LADDER TO LADDER BRACKETS	W-170	#10	
	4	BOLTS & NUTS 3/8x1 5/8" FOR FASTENING LADDER TO BASE PLATES STANDARD			
	2	LADDER BRACKETS, B=19⅛, A=7⅝, O.D. POLE	W-170	#1	
	2	LADDER BRACKETS, B=23½, A=8⅝, O.D. POLE	W-170	#1	
	2	LADDER BRACKETS, B=31¾, A=8⅝, O.D. POLE	W-170	#1	
	2	LADDER CLAMPS, FRONT & BACK WITHOUT BOLTS, FOR 5 9/16, O.D. POLE	W-170	#5	
	10	BOLTS & NUTS, ½x1½, FOR ABOVE LADDER BRACKETS AND CLAMPS	W-170	#9	
	2	MECHANISM CASES, COMPLET, PER STOCK LIST Z-128	Z-128		
	2	BASE PLATES, FOR CASES	Z-145		
	8	BOLTS & NUTS, 1"x2⅝", FOR FASTENINGS CASES TO BASE PLATES	Z-145		
	24	ROUND HEAD RIVETS, ½x1¾ FOR FASTENING BASE PLATE TO CHANNELS	Z-145		
	2	SECTIONS 5" PIPE FOR TOP POLES, LENGTH 55⅝"			
	2	BASE CASTINGS FOR TOP POLES	T-173	C-172	C-1
	8	BOLTS & NUTS 1"x4" FOR FASTENING BASE CASTINGS TO CASES STANDARD			
	2	SEMAPHORE BEARINGS COMPLET, PER STOCK LISTS V-128 & V-130	V-128 V-130		
	2	SET SCREWS 5/8"x1¾" FOR STOPS			
	2	PINNACLE CASTINGS	T-172	C-171	C-1
	2	UNIVERSAL, 90° SPECTACLES, COMPLET, PER STOCK LIST, V-127 WITHOUT STUDS	V-127		
	2	SIGNAL BLADES, FITTED WITH DOOR RAIL (SPECIFY)			
	2	SECTIONS, 1½ PIPE, 3'-7" TO BE SELECTED & PREPARED TO TAKE STANDARD FITTINGS & ELBOW AS SHOWN, FOR HAND RAIL ON THIS PRINT	W-196		
	1	SECTION, 1½ PIPE, FOR HAND RAIL TO TAKE ELBOW AND BASE FITTINGS AS SHOWN ON THIS PRINT 3'-6"	W-196		
	1	1½ STD. PIPE ELBOW (SELECT)			
	1	MALLEABLE PIPE FITTING #4, ELECTRIC RAILWAY EQUIPMENT CO, CATALOGUE NO.12, OR EQUIVALENT			
	1	MALLEABLE PIPE FITTING #3, ELECTRIC RAILWAY EQUIPMENT CO, CATALOGUE NO.12, OR EQUIVALENT			
	1	MALLEABLE PIPE FITTING #14 ELECTRIC RAILWAY EQUIPMENT CO, CATALOGUE #12, OR EQUIVALENT, WITH BOLTS & NUTS REQUIRED FOR FASTENING TO BASE PLATE			
	1	WROUGHT IRON BASE PLATE FOR FITTING NO 14 ABOVE, TO BE DRILLED WITH FITTING IN PLACE.	Z-145	#2	
	6	ROUND HEAD RIVETS, ½x1", FOR FASTENING ABOVE PLATE TO CHANNELS			

BRACKET POLE

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At 112th Street, the second switch indicator circuit is shown, in connection with the interlocking plant. It is practically the same as the switch indicator at Pullman Junction and its circuit will be understood without difficulty. The next switch indicator is located just south of 112th Street, on the southbound track, and its connections are identical with that at Pullman Junction. Two more switch indicators are located on the northbound track at Burnham. Their location relative to the interlocking plant necessitates the same sort of arrangement in their circuits.

At State Line interlocking plant, it should be noted that signal 233 operates in connection with the semi-automatic signal 162 and the mechanically operated signal 158; that is, signals 162 and 158 must be in the clear position in order to clear signal 233. Signal 158 is operated mechanically from the interlocking tower. The circuit closers shown in connection with it are the same as the mechanically operated signal at Hammond Junction, and an assembled drawing, which will be easily understood, is shown in Fig. 30, page 93.

In this brief explanation of the circuits presented in the circuit diagram of Fig. 33, the writer desires only to assist those who may have the patience and interest to trace out the circuits to their own satisfaction, to make a start in the right direction.

PAT. # C254
DET. # 10
DET. # 12
DET. # 6
DET. # 1
PAT. # C250
DET. # 4
DET. # 7
DET. # 13
PAT. # C251
DET. # 2
DET. # 9
PAT. # C251
DET. # 8
DET. # 5

Fig 30

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